

ABSTRACTS
AMERICAN DAIRY SCIENCE ASSOCIATION
AMERICAN SOCIETY OF ANIMAL SCIENCE

July 24–28, 2000
Baltimore, Maryland

* Author Presenting Paper

OPENING SESSION ABSTRACTS

2000 Innovation in transferring research into practice. B.D. Moser*, *The Ohio State University*.

Stakeholder and governmental support for research programs is vital. The best way to garner support: find out what the public wants, deliver that to them, and then let them know that it's delivered. This is especially important given that most of our constituents are no longer food producers.

County-based councils and advisory groups are one way to achieve this. Ongoing and regular discussions with stakeholders through these groups can alert colleges to current needs so that they can tailor work and establish Extension and research priorities for the coming year. Another successful model is a high-level advisory council composed of opinion leaders who provide advice directly to the dean and meet to discuss current topics. Once efforts are made to address needs, it's imperative to communicate success stories to constituents, legislators and other leaders.

Teamwork allows most efficient and effective delivery of information. Teams that focus on topics of major importance provide a strong service to our constituents and illustrate responsiveness. However, traditional methods of rewarding faculty tend to acknowledge individual accomplishments while discouraging team efforts. New reward and tenure systems have been developed that honor academic freedom while addressing the needs of taxpayers and governing boards.

Technology can help us meet our goals. Distance education and use of the World Wide Web can help us multiply our reach immensely.

We've learned from our constituents that globalization is key to our success. I commend the EAAP and the ASAS/ADSA for working together, encouraging information and technology transfer across the world.

Key Words: Support, Teamwork, Rewards

2001 Governance of innovation in animal production: New roles for science, business and the public sector. G. van Dijk*¹ and P.W.J. van Boekel², ¹*Wageningen University, The Netherlands*, ²*Nyenrode University, The Netherlands*.

Innovation results from a variety of sources. Although lacking well-defined and testable theories it is widely held that systematic research almost linearly translates into innovation and enhanced efficiency. The type of innovation effectuated by a system of experimental stations, research institutes and universities, all with specific core competences, has shown itself as predominantly incremental: improving performance on individual supply chain levels. In this paper, however, it is shown that market orientation overthrows existing models of innovation: certain market conditions require explorative market learning (e.g. new concepts) instead of exploitative market learning. Concerning strategic research three cost-return concepts can be identified: collectively financed research - cost-return relationships at society level (lower production costs, consumer prices); firm financed open knowledge system - returns by patentation; closed knowledge system - cost-return relationships by marketing. Differentiation and change of markets and new demands from supply chain partners press for firm financed innovation. Whereas weaker partners favour stable partnerships and contracting, and dominant retailers and brand-owning processors strive for flexibility and more freely expressed innovation. Innovation thus increasingly shows itself as an assembly of parts - biotechnology (new techniques in particular), ICT-services, animal product specification (e.g. tracking & tracing), knowledge embodied in products and equipment - put together by entrepreneurial practices of networking. Case studies will be presented which illustrate new innovation practices. Emphasis is put on governance methods, effects of entrepreneurial conditions, the role of government (non-marketable public concerns), contract research and business strategies. It is indicated that changes in patterns of innovation fit into the current conversion from old into new economy.

ANIMAL BEHAVIOR AND WELL-BEING AND CONTEMPORARY AND EMERGING ISSUES SYMPOSIUM

Livestock Transport: Industry Issues and Research Challenges

1 History and development of European and North American transport regulations including trade issues. T.C. Harris*, *AATA - Animal Transportation Association*.

The transport of animals was largely unregulated until the beginning of the 20th century. Pressures from public concern led to the earliest legislation. In general, only amendments were added until the development of the European Union. This resulted in wider publicity, the removal of border controls, an increase in distances transported, loss of control by individual Departments of Agriculture, public concern and even civil unrest. Major changes have been introduced in the EU and in the Council of Europe. This will have implications for international trade. The author will develop these themes, including the Conference highlight "From Research to Innovation", and suggest a course of action for the future.

Key Words: Animal Transport, Legislation, Welfare

2 Perspectives on transportation issues. T. Grandin*, *Colorado State University, Fort Collins*.

One of the most important issues is starting with an animal that is fit for transport. It is impossible to assure good animal welfare during transport if the animal is unfit. Severely lame or weak, emaciated animals are not fit for transport. Recent figures on the incidence of downer non-ambulatory cull dairy cows show that the problem has become worse since 1993. In beef cattle there has been a slight improvement. A major factor causing unfitness in some cows and pigs is overselection for milk or meat production. Lameness may be increasing in some high producing dairy cows and sows. Modern hybrid pigs which have been selected for rapid growth, leanness and a large loin area are often prone to stress which causes the pig to become non-ambulatory. Observations at packing plants indicate that in certain genetic lines the incidence of transit deaths and "stressor" pigs has increased. Some of these pigs are so fragile that transport insurance is difficult to obtain. These pigs have a very excitable temperament which makes loading and unloading a truck more difficult. Another problem area is transport of day old "bobby" dairy calves before they can walk. Good management is essential. Tired loading crews or overloading of trucks will increase bruises and injuries. Careful driving and avoiding sudden stops and starts will reduce injuries due to animals falling down.

Key Words: Animal welfare, Transportation, Slaughter plants

3 Overview of the biology of stress. E.H. von Borell*, *Martin-Luther-University Halle-Wittenberg*.

Stress is a broad term which implies a threat to which the body needs to adjust. Stress may be classified as physical, psychological, or interoceptive in nature, but usually contains components of all three classifications. The adjustment to stress induces a broad range of neuroendocrine, physiological and behavioral changes to allow for a rapid recovery or adaptation to the change. In the past, housing systems and handling procedures for livestock were mainly assessed by descriptive behavioral studies using indicators presumed to be related to stress (i.e., stereotypic behaviors). Physiological indicators included endocrine changes on the pituitary-adrenal-axis by measuring adrenocorticotropin, corticosteroids and catecholamines. The neuroendocrine and immune system has been studied in relation to stress effects at a cellular, humoral or neural level during the last decade. All these studies were often conducted in an isolated manner without considering that the neuroendocrine and immune system are communicating with each other and are ultimately influenced by the animal's individual perception of a stressor. Transportation is considered as a major stressor for livestock and might have deleterious effects on the health, well-being, performance and ultimately on product quality. Studies on the assessment of stress during animal transportation require non-invasive methods, as classical approaches of data collection with direct human interference (i.e., for blood collection) might directly alter the stress response. Telemetric devices for measuring heart and respiration rate, body temperature and blood pressure are useful tools to obtain undisturbed responses. Also, non-invasive analysis of stress indicating metabolites in saliva, feces or urine has been recently developed and validated. Parallel to behavioral observations (via video

recordings), these physiological measurements provide valuable information on how livestock handling and transportation can be improved in the near future.

Key Words: Stress, Livestock, Transportation

4 Cattle transport: historical and future perspectives. J. C. Swanson*¹ and J. Morrow-Tesch², ¹*Kansas State University, Manhattan*, ²*USDA-ARS, Lubbock, TX*.

Transportation is generally regarded as stressful to cattle since it includes both physical and psychological stimuli that may be aversive. Behavior, pathology, and stress physiology are all used to identify stress in response to transportation. Physiological measures indicate that transport of cattle can result in immunosuppression which can lead to increased susceptibility to disease and may result in increased pathogen shedding. Empirical evidence shows that the neutrophil to lymphocyte ratio is markedly increased when cattle are handled and transported. It has also been observed that social behaviors (butt, push, threat, mount) are reduced by crowding and motion of the truck. Loading, loss of balance and falling are distressful to cattle. For example, mean heart rates for cattle transported on smooth roads are lower than for cattle transported on rough country roads or suburban roads with frequent intersections. Age at transport may also play a role. Young cattle (less than 4 weeks of age) do not tolerate transport as easily as older animals. Young cattle do not show a typical physiological stress response as seen in older cattle. This evidence, along with mixing practices typical of loads of calves, would make these animals more susceptible to disease. Various strategies have been attempted to reduce cattle response to transportation stress including preconditioning, administration of vitamins, vaccines, feeding high-energy diets and electrolyte therapy. These approaches to managing transport stress have met with little success. Newer methods to reverse the negative physiological and behavioral responses to stress are needed. Also, research is needed to elucidate the relationship of transport stress to the spread of pathogens of concern to food safety.

Key Words: Cattle, Transport, Well-being

5 Transportation of cattle in the dairy industry: current research and future directions. S. D. Eicher*, *USDA-ARS, West Lafayette, IN*.

Traditionally a heifer lived on one farm throughout life. Recently, transportation is becoming routine. Heifers are moved off the dairy within the first week of life to separate rearing facilities and then returned to the dairy prior to calving. Transportation consists of several elements; loading/unloading, mixing, and confinement on a stationary and then moving vehicle. Ramps are not an obstacle for adult cattle, however for neonatal calves ramp inclines can create well-being issues. Stationary confinement of cows is less stressful than the motion of transport. During transport adult cattle stand more, but lie more during the recovery period. Footing is affected by driver, driving conditions, and stocking density (room to orient themselves in a particular direction is important). Environmental studies have shown that thermal requirements for adult cattle are of concern above 30°C, but neonatal calves are most affected by low temperatures. Calves habituate to transport, unlike cows. Young calves exhibit less physiological stress with transport, but succumb to post-secondary mortality which is correlated with age at transport. Transport stress in cattle is characterized by increased heart rate and cortisol concentrations, enzymatic changes, impaired LH surge, and immunological effects. Duration of the journey has a greater impact than the distance of the trip and after long transport, most animals drink and then lie down (especially young calves). Therapies during and following transport show that water or electrolytes are important. These data point to the need for research of better methods of loading neonatal calves and boosting innate immunity following transport. Studies of physical aspects of the transport vehicle such as tire pressure and bedding may be important for calves that spend more time lying. Research on transport and mixing of first-calf heifers is unexplored and needed because replacement heifers are frequently moved. Behavior studies and

strategies to accommodate behavior of cows and calves may facilitate improved truck and facility design and management.

Key Words: Transport, Dairy

6 Swine transportation: a critical review. A.J. Zanella*¹,
¹*Department of Animal Science, Michigan State University, East Lansing.*

Poor management during loading and transportation may contribute to the occurrence of sudden death, bruising, pale soft and exudative (PSE) meat and dark firm and dry (DFD) meat in pigs. In the United States, economic losses associated with the conditions above were estimated at more than 43 million dollars in 1994. New laws are in place in different parts of the world regulating pig transportation. Hogs may be transported for a maximum of 24 hours provided that they have water at all times during transport (European Convention for the Protection of Farm Animals During International Transport, 1995). Federal regulations in Canada dictates standards related to management during loading and unloading, duration of transportation, provision food and water, mandatory rest, protection against injury and protection against extreme weather conditions. The welfare of pigs during loading and

transportation may be poor. Pigs are exposed to a novel environment and they are often mixed with unfamiliar animals. Noise and vibration can pose severe challenges to the naïve sensory system of the animals. Experimental work demonstrated that pigs deemed vibration as aversive. Injuries ranging from skin lesions to severe cuts and bruises may be observed in pigs mixed with unfamiliar animals during loading and transportation. It has been suggested that pigs may experience motion sickness during road transport. Fasting pigs before transportation reduces mortality and facilitate the work of eviscerating the carcasses. On the other hand, the absence of solids in the stomach may increase gastric pH facilitating the survival and proliferation of pathogens. Our research has focused on the impact of early environment and handling techniques on the responses of pigs to transportation. Transportation of recently weaned pigs, growers and market weight pigs caused an activation of the stress axis and marked behavioral changes. We demonstrated that pigs which were loaded using electric prod had higher levels of activity (rooting and investigative behavior), heart rate and rectal temperature during the 15 minutes post-loading than pigs loaded using a conventional hurdle. Transportation of breeding stock and weaners has not received much attention and further research in this area is needed.

Key Words: Pigs, Transportation, Welfare

ANIMAL HEALTH SYMPOSIUM

Nutritional and Environmental Factors Influencing Immunity

7 At the interface of environment-immune interactions: cytokine and growth factor receptors. K.W. Kelley*, *University of Illinois, Urbana.*

Activation of the immune system by foreign environmental stimuli causes a number of important changes, including a reduction in feed intake and body growth. These effects are mediated by cytokine receptors that are expressed on a variety of cells. Insulin-like growth factor-I (IGF-I) is well known to promote lean body growth. The receptor for IGF-I is expressed on cells of the hematopoietic lineage. IGF-I not only increases mitotic activity of promyeloid cells, but it also acts as a survival factor (J. Immunol., 1999, 162:4542) and promotes differentiation into both neutrophils (J. Immunol., 2000, 164:113) and macrophages (Molec. Cell. Biol., 1999, 19:6229). The latter effects are mediated by the intrinsic tyrosine kinase activity of the beta chains of the IGF-I receptor, which leads to tyrosine phosphorylation of the insulin-receptor substrate-1 or -2 (IRS-1/2). Activated IRS-1/2 utilizes SH2 domains on the p85 regulatory subunit of phosphatidylinositol 3'-kinase (PI 3-kinase) to recruit the catalytic p110 subunit to the membrane. Cytokine and growth factor receptors are also expressed within the central nervous system. Recent evidence suggests that receptor signaling cascades for both tumor necrosis factor- α (TNF) and IGF-I routinely interact to affect cell survival (Proc. Natl. Acad. Sci. U.S.A., 1999, 96:9879). The ability of IGF-I to promote survival of cerebellar granule neurons is reduced by 50% with as little as 10 pg/ml of TNF. This is caused by the activated TNF receptor inhibiting the ability of IGF-I to tyrosine phosphorylate IRS-2 and to subsequently increase the enzymatic activity of PI 3-kinase. TNF has also been shown to inhibit protein synthesis in human skeletal myoblasts. We speculate that TNF acts similarly by silencing signals that emanate from the activated IGF-I receptor (Trends Neurosci., 2000, 23:175), thereby inducing receptor resistance. This hypothesis forms a molecular framework for understanding how co-activation of cytokine and growth factor receptors regulates animal growth and well being. (Supported by MH-51569, DK-49311 and AG-06246)

Key Words: IGF-I receptor, TNF receptors, Intracellular crosstalk

8 Association between retained placenta and neutrophil function in dairy cattle. K. Kimura*¹, J. Goff¹, and H. Tyler²,
¹*National Animal Disease Center, USDA-ARS,* ²*Iowa State University, Ames.*

No single factor explains why cows develop retained placentas (RP). Gunnink (Vet. Quarterly, 1984) proposed the theory that the fetal placenta had to be recognized as foreign by the maternal immune system and "rejected" for normal expulsion of the placenta to occur. We examined the relationship between RP and neutrophil function in periparturient dairy cows. The ability of the neutrophils to recognize fetal tissue

was assessed by a chemotaxis assay (CHEM). In this assay cotyledon homogenate from a normally expelled placenta is placed in the bottom of a Boyden chamber. A polycarbonate membrane (pore size 5 meter) is placed over the homogenate and neutrophils are placed in the top portion of the chamber. The polycarbonate membrane theoretically allows placental chemoattractants to pass into the upper chamber and attract neutrophils to pass through the membrane. After 30 min incubation the number of neutrophils attached to the bottom side (cotyledon homogenate side) of polycarbonate membrane were counted under the microscope. Typically in cows that responded well to the placental chemoattractants around 400 neutrophils were counted in 5 microscope fields. Cows were considered non-responders when there were fewer than 200 neutrophils /5 fields. Neutrophil killing abilities were estimated by determining myeloperoxidase activity in a protein iodination assay (IOD) and is expressed as a % of lab controls. Blood samples were obtained periodically prior to calving and for the first day after calving from 24 cows (3 cows developed RP) on one farm and 58 cows (6 cows developed RP) at another. The day of calving 7 of 9 cows that developed RP could be classified as non-responders in the CHEM assay while only 5 of the 73 cows that expelled the placenta normally were considered CHEM non-responders (Chi square, $p < 0.01$). Prior to calving the differences were present but were not as marked. Neutrophil IOD index was consistently lower in RP cows (66%) than in non-RP cows (115%) at calving ($p < 0.05$). This difference also was observed prior to calving. These data support the theory that the presence of a functional neutrophil is critical to normal expulsion of the fetal membranes.

Key Words: Retained placenta, Dairy cattle, Neutrophil function

9 Lipid-soluble antioxidant vitamins on immunity. B. P. Chew and J. S. Park, *Washington State University, Pullman.*

The relationship between vitamin deficiencies and infectious disease morbidity and mortality has been known for centuries. Interest on the importance of the lipid-soluble antioxidant vitamins retinoids, carotenoids and tocopherols has increased in recent years due to their role in disease etiology. The underlying mechanism of action of these micronutrients is, in a large part, attributed to their immune modulatory action. Vitamin A and related retinoids play important roles in regulating mucosal immunity, B and T cell responses, cytokine production, and neutrophil function. The vitamin A ligands all-trans and 9-cis retinoid acid bind to the retinoid acid receptors RAR and RXR; the latter dimerize and bind to retinoic acid response elements on target genes. Dietary carotenoids also have been reported to enhance both humoral and cell-mediated immune function in numerous species. The action of carotenoids has previously been attributed to their provitamin A activity. However, carotenoids such as astaxanthin and lutein do not possess provitamin A activity but have similar immune-enhancing action. Vitamin E compounds such as the tocopherols and tocotrienols

are chain-breaking antioxidants against lipid peroxidation and regulate prostaglandin and leukotriene production. They similarly modulate immune function including changes in lymphocyte subsets, cytokine production, humoral and cell-mediated immunity, and neutrophil function. Recent studies on the role of retinoids, carotenoids and tocopherol in gene regulation and apoptosis have advanced our knowledge on the

mechanism by which they regulate immunity and health. This discussion will address specific immune responses and their relevance to animal health and production.

Key Words: Lipid-soluble vitamins, Immunity

BREEDING AND GENETICS SYMPOSIUM A Tribute to A. E. Freeman, Iowa State University

10 The contributions of A. E. Freeman. R. E. Pearson*¹, ¹*Virginia Polytechnic Institute and State University, Blacksburg.*

Dr. Albert Eugene (Gene) Freeman, completed his B. S. and M. S. degrees at University of West Virginia in 1952, and 1954, and his Ph.D. at Cornell University in 1957. In 1957, he started his professional career at Iowa State University and since 1978 has served as Charles F. Curtiss Distinguished Professor of Agriculture in the Animal Science Department. His major contributions during his highly productive career have been in three areas: training of M. S. and Ph.D. candidates; publication of research results; and interpreting research findings to the dairy cattle improvement industry and producers. One of his greatest attributes has been his ability to attract researchers from diverse areas to collaborate with him and his students on innovative research that covers virtually all aspects of dairy cattle breeding. Dr. Freeman has guided more than 40 Ph.D. and 30 M.S. students. These students came from the U.S. and many other parts of the world and a number are now in positions of leadership in their respective countries. They are primarily employed on university faculties, in various aspects of the genetic improvement industry, and as dairy producers. Dr. Freeman's research has covered a vast range of topics and has involved a number of experimental approaches from designed experiments and field studies to simulation and analysis of field data. His research has formed the basis of major improvements in dairy cattle breeding practices. He has provided leadership to the animal breeding group at Ames, the long term regional breeding projects conducted across the U.S., the American Dairy Science Association, and the World Congress on Genetics Applied to Livestock Production. In recognition of his many accomplishments, he has received numerous major awards from a variety of organizations. Dr. Freeman has made a significant impact on the genetic improvement of food producing animals world wide through his research and through the students he has trained.

Key Words: Animal Breeding, Research, Graduate Training

11 What can animal breeders and corn breeders learn from each other? K. G. Boldman*, *Monsanto Company, Savoy, IL.*

In both commercial animal and corn breeding programs, the objective is to choose superior individuals or lines to: 1) produce germplasm or hybrid progeny for current sale, and 2) produce future generations. In corn breeding, inbred lines are crossed to produce commercial hybrids and to produce F2 progeny which are selected and selfed to produce new inbred lines. To maximize profits of a corn or animal breeding company, individuals which have the potential to make a significant contribution to a commercial breeding program must be quickly and accurately identified using resources as efficiently as possible. Design of the two phases of a commercial breeding program - crossing and evaluation - are determined by the reproductive biology of the species and, to a large extent, tradition. Current commercial animal and corn breeding programs differ in many regards including: use (avoidance) of inbreeding; public versus private genetic evaluations; application of mixed model methodology including utilization of relative information; use of molecular markers in selection; and design and size of testing programs. On the business side, corn and animal breeding programs currently differ in how proprietary germplasm is sold or licensed and protected. In the future, it is likely that current or new breeding techniques will be used in both commercial corn and animal breeding programs. The use of common techniques between both corn and animal breeding will be the result of scientific developments, e.g., new reproductive technologies and a move from selection at the whole organism (phenotypic) level toward selection at the

DNA (genotypic) level, as well as potential business changes, e.g., mergers between breeding companies and acquisitions of agricultural breeding companies by large pharmaceutical or "Life Sciences" companies.

Key Words: Genetic Improvement, Selection, Corn Breeding

12 Poultry breeding: structure, traits, realized responses, and the future. M. T. Kuhn*, *Hy-Line International.*

In contrast to large animal livestock species, commercial egg producers purchase all female replacements for their flocks. These replacements are purchased from layer breeding companies such as Hy-Line International. To remain competitive, breeding companies must constantly improve their existing varieties as well as test and develop potential new varieties. Commercial varieties are produced from a 4-way cross of pure lines. Improvement in commercials is brought about by selection on the pure lines. At Hy-Line, there are two sources of data used for selection. One is records on pure line, fully pedigreed females housed at a central location called the research farm. The research farm, however, represents a specialized environment, having single bird cages and much tighter biosecurity than commercial operations. Because of potential GxE interaction, then, a second source of data is on commercial-type birds, identified by sire, which are housed in actual commercial operations. Primary traits under selection include egg production, egg weight, albumen height, shell color, shell strength, feed efficiency, sexual maturity, body weight, temperament, livability, and resistance to Marek's disease. Most of these traits are measured at both the research farm and in the (commercial) field test. Even for lines which have been closed and under selection for over 40 years, response to selection and heritabilities greater than zero are still being observed for all traits. The two most notable future directions will probably be changes in the market and implementation of marker-assisted selection. Some possible market changes include consumer demand for particular egg solid contents; e.g., lipid or cholesterol content, yolk weight, total egg solids. Demand for a bird which performs well on the floor or under free range conditions will also likely increase in the future. Hy-Line has its own molecular biology lab and is currently searching for markers associated with traits of interest. Utilization of marker information will likely include both introgression to form new pure lines as well as markers for within line selection.

Key Words: Poultry Breeding, Breeding Program, Realized Response

13 Genetic control of dairy cattle behavior. M. M. Schutz* and E. A. Pajor, *Purdue University, West Lafayette, IN.*

Past efforts to understand the role of genetics in the expression of behavior in cattle, and livestock in general, have emphasized changes in behavior related to the domestication process. Especially in intensive systems, domestic cattle may exhibit muted expressions of innate behavior when they are provided with food, shelter, and protection from predators. When provision of these necessities is inadequate or curtailed, magnification of behaviors may occur. The goal of this paper is to explore the prospects of enhancing behavior genetically to better adapt dairy cattle to future dairy production systems. In dairy cattle, behavior traits may be categorized as feeding, reproductive, maternal, social, learning, and human-animal interaction. Temperament, when scored subjectively and retrospectively by the human handler, is a measure of human-animal interaction. It has been the most evaluated behavior trait in cattle, and is related to ease of handling, milking efficiency, and handler safety. Recent estimates of heritability for temperament range from .09 to .25, with differences observed for breeds. Thus, temperament may have potential for inclusion in breeding objectives. Traits that affect feeding behavior, such as time spent grazing and aggressiveness at the feed bunk in confinement systems, have great economic value. However,

little is known about genetic control of their expression. Duration and intensity of estrus behavior may be genetically influenced and is becoming increasingly important as labor for estrus detection on expanding dairy farms becomes less available and more expensive. In the past, routine collection of behavior measurements has been difficult or impossible on a large scale, even in herds that routinely progeny-tested young bulls. Future progeny-test programs or genetic improvement schemes, such as Multiple Ovulation and Embryo Transfer (MOET), that focus intensive data collection a smaller number of herds may foster recording of economically important behavior traits like temperament, estrus expression, and measures of feeding behavior.

Key Words: Genetics, Behavior, Dairy cattle

14 Genetic improvement of resistance to infectious diseases in livestock. J.C. Detilleux*¹, ¹University of Liege - Faculty of Veterinary Medicine.

Despite traditional disease control measures, losses attributable to infectious diseases continue to impede the livestock industries. The emergence of previously undescribed pathogens has been a feature of the end of this century. Increased global travel and semen exchange has contributed to the dissemination of pathogens previously confined to specific regions. In addition, it is now clear that bacterial pathogens cause diseases previously thought not to be infectious. Old disease have returned accompanied by the emergence of antibiotic-resistant strains. No new class of antibiotics has been discovered in the past three decades and derivative of current antibiotics soon encounter resistance. Other methods are thus desperately needed to counter diseases previously treated by conventional antibiotics. One approach is to improve genetic resistance to infectious pathogens. Evidently, selection for the most resistant animals necessitates the understanding of the components of the host response that lead to elimination of the invading pathogen and resolution of disease. But, it requires also the identification and characterization of the virulence factors and the *in vivo* survival mechanisms of the invading pathogen. The functional relationship between the pathogen transmission rate and its virulence within- and between-hosts should also be considered. Finally, it must be recognized that current host-pathogen relationships are shaped by co-evolutionary mechanisms between host defence mechanisms and pathogen genetic diversity. It is therefore distressing that studies dealing with infectious disease have developed until now separately. The joint efforts of many different teams with complementary expertises are necessary to evaluate simultaneously the impact of all disease determinants and of their interaction on natural resistance to infectious disease.

Key Words: Disease Resistance

15 Methods to combine information from separate sources. P.M. VanRaden*, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Separate estimates of breeding value can be combined by selection index if a combined analysis of all data is not possible or efficient. Computation is fast but not exact if the reliabilities of the separate estimates are approximate, if the extent of overlap of the data sets is unknown, or if selection has occurred across the data sets. Selection index can be used to combine single-trait evaluations into approximate multiple-trait evaluations or single-country rankings into multiple-country rankings for either males or females. Iteration can be avoided by including parent evaluations as data and combining parent evaluations before progeny evaluations. Some information would be lost because grandprogeny data from other countries would not contribute back to grandparents as a result of the order in which information is combined. Exchange of sire and dam evaluations could provide a closer connection between national and international evaluations and may be more accurate than the current sire-maternal grandsire model used internationally. Reliabilities of the animal, its sire, and its dam can be used to backsolve for daughter equivalents from parents versus those from progeny and own records. An estimated breeding value can be adjusted separately for added parent information or for added progeny information. If either parent is unknown, the progeny's Mendelian sampling is confounded with the unknown parents' deviation from genetic group solution. Variance estimation can be made simpler by using the sum of squared Mendelian sampling effects as the quadratic form instead of using the relationship matrix inverse

pre- and post-multiplied by the breeding values. The expectation involves sum of reliabilities, sum of reliabilities from parent average, and covariance of parent and progeny breeding values, which can be determined from reliabilities for the animal and its parents. Selection index methods may allow current multiple-trait across-country evaluations for bulls to be improved and to be extended to cows.

Key Words: Selection index, Genetic evaluation, Reliability

16 The effect of Holsteinization on intensive pastoral dairy farming in New Zealand. B. L. Harris*¹ and E. Kolver², ¹Livestock Improvement, Hamilton, New Zealand, ²Dairy Research Corporation, Hamilton, New Zealand.

The objective of this presentation is to compare the production, survival and fertility of strains of Holstein-Friesian (HF) cows, Jersey cows, and their crosses reared under an intensive-seasonal-pastoral dairy farming system in New Zealand (NZ). Results from trials of cows, which differed genetically for liveweight, conducted at Massey University (NZ) have shown that the high liveweight (LW) line had reduced fertility compared to the low LW line. The high LW line had a greater proportion of overseas HF genetics than the low line suggesting there may be strain differences in fertility which may be expressed in reduced survival for the overseas HF strain. Similar results, which will be summarised, have been obtained at Dairy Research Corporation (NZ) by comparing NZ HF and Dutch HF strain under two feeding regimes: a TMR feeding system and a rotational pasture grazing system. These results have motivated a major study by Livestock Improvement to investigate the production, survival and fertility of strains of HF cows, Jersey cows, and crosses between these breeds and strains within the HF breed. The data were collected on Livestock Improvement's Sire proving scheme herds. These commercial herds are spread evenly across NZ, have intensive data recording and have up to 95% of their cows artificial inseminated to unproven sires. The data consisted of 104,862 first-lactation cows calving in seasons 1987 to 1999.

Key Words: Holstien, Fertility, Crossbreeding

17 2020 Vision? - The future of dairy cattle breeding from an academic perspective. P.J. Boettcher*, *University of Guelph, Guelph, Ontario, Canada.*

In the future, all aspects of dairy cattle breeding will continue to be shaped by trends in the industry that have been occurring for the past generation. Dairy farms will continue to increase in size and decrease in number. Advancement will continue in the development and adoption of computers, genomics, and other technologies, and the dairy cattle breeding industry will continue to become more global in its scale. These factors will both directly and indirectly affect the research and teaching activities of those who chose to follow a career path similar to Gene Freeman's. A major consequence of these factors is that as farm sizes increase and the proportion of the public directly involved in dairy production decreases, the public need and support for teaching and research in dairy cattle breeding are also likely to dwindle. Family farms will likely be increasingly viewed as businesses and asked to directly support a greater portion of their research and development activities. Nevertheless, the public will still influence research priorities. Health and well being of cattle and genetic diversity will likely become more important as consumers react to concerns about food safety and animal welfare. These factors will also be of direct concern to breeders, because they influence profit by affecting costs of production. Producers will put increased value on trouble-free cattle that demand less individual attention. Computers and automated equipment will allow data for health and functional traits to be captured efficiently, which will be necessary before either traditional or genomics based selection tools can be applied. New technology resulting from research will be transferred to the field and applied more quickly. Graduate students will require a very diverse training. Although graduates will probably work in very specialized fields (and probably not in academics) and perform relatively specialized tasks, they will likely be doing so as members of larger teams. The ability to interact and communicate with their collaborators, as well as breeders, industry representatives and the general public, will be paramount.

18 A futuristic look at the dairy cattle genetics industry.
R. D. Welper*, *Alta Genetics Inc.*

The structure of the dairy cattle genetics industry has changed over the last decade, as bull numbers have declined and mergers have significantly decreased the number of breeding companies. Mergers and alliances will continue over the next few decades, as low blend prices and increasing global competition will force decreased costs and increased efficiencies in the dairy cattle genetics industry. Dairy cattle semen has become a commodity with the value set by genetic evaluations done by third party organizations. Sharing of superior genetic lines has been the trademark of the dairy cattle genetics industry that has set it apart from other genetics industries. The major challenge for the remaining breeding companies will be to modify current practices in order to differentiate their product lines. This will require non-traditional thinking and novel

methods of utilizing new and existing technologies. The next step will be to tailor genetic selection programs to meet the specific needs of consumers and milk processors. Technologies such as nucleus herds, semen sexing, progeny test schemes, genomics, and cloning are not new to this industry, as the initial research on these projects was done decades ago. Application and refinement of these and other technologies on a large scale, however, will be the main focus of the dairy cattle genetics industry over the next few decades. Genetic selection strategies may focus more on fitness traits, allelic frequencies, crossbreeding, and bio-security. Data, genetic evaluations, and genetic lines may become proprietary in order to increase differentiation and create unique product lines, as is currently done in the swine, poultry, and plant breeding industries.

Key Words: Breeding, Dairy cattle, Genetic evaluations

BREEDING AND GENETICS SYMPOSIUM
Inbreeding in Animal Agriculture

19 Controlling inbreeding in modern breeding programs.
K. A. Weigel*, *University of Wisconsin, Madison.*

Modern livestock breeding programs feature accurate methods for breeding value estimation and heavy use of reproductive technology. Although such programs result in rapid genetic progress, they also lead to an accumulation of inbreeding via increased impact of a few selected individuals or families. For this reason, inbreeding is increasing at an accelerating rate in most species, and economic losses due to inbreeding depression are a serious concern. Inbreeding depression occurs for performance traits, such as growth or milk production, and for health traits, such as fertility or survival. Crossbreeding can alleviate inbreeding problems in commercial populations of some species, but programs based on rotational crossing or continual F1 production (using in vitro fertilization) still require maintenance of purebred parental lines. Most research has focused on preservation of rare breeds or maintenance of diversity within closed nucleus breeding schemes. However, the apparently large population size of many livestock breeds is misleading, because inbreeding is a function of selection intensity and effective population size. The latter often bears little resemblance to actual population size, and commercial populations of several million animals may have an effective population size of less than 100. Strategies for maintaining variation by restricting relationships between selected animals or artificially increasing the emphasis on within-family information have been suggested, but few are willing to sacrifice near term economic gains in favor of long term diversity issues. Corrective mating programs are already widely used in certain species, and these can be easily modified to consider inbreeding avoidance. Programs based on selection for total economic merit adjusted for inbreeding depression are most efficient, and these can lead to significant benefits in the next generation. In practice, however, missing pedigree information poses a problem. International sourcing of genetic material is also a possibility, but in the long term this may lead to a reduction in the effective size of the global population.

Key Words: Inbreeding, Genetic diversity, Breeding programs

20 The effect of combined crossbred purebred selection on the rate of inbreeding. P. Bijma*¹, J. A. M. Van Arendonk¹, and J. A. Woolliams², ¹*Animal Breeding and Genetics Group, Wageningen University, The Netherlands*, ²*Roslin Institute (Edinburgh), Roslin, Midlothian, UK.*

In evaluations of combined crossbred purebred selection (CCPS) schemes, the effect of the rate of inbreeding (ΔF) has been ignored up till now. With CCPS, family information receives substantial emphasis, which increases the probability of co-selection of relatives and thus increases ΔF . In a deterministic study, rates of genetic gain (ΔG) and inbreeding were compared between pure line selection (PLS) and CCPS, for the sire line of a three-way cross. Purebred performance and crossbred performance were treated as genetically correlated traits assuming the infinitesimal model. Selection was by truncation on estimated breeding values for crossbred performance. Rates of gain were predicted using pseudo-BLUP selection index theory. Rates of inbreeding were predicted accurately, using recently developed methods based on long-term genetic contributions. For a given family structure, it was found that changing from PLS to CCPS may increase ΔF by a factor 2.14. To achieve the same ΔF , CCPS required a larger number of

parents than PLS, in particular with high heritabilities (h^2) and low purebred-crossbred genetic correlations (r_{pc}). The superiority of CCPS over PLS was judged by comparing ΔG from both selection strategies at the same ΔF . When compared at the same ΔF , CCPS was superior to PLS and the superiority of CCPS was only moderately reduced compared to the situation without a restriction on ΔF . For example, for $h^2 = 0.4$, $r_{pc} = 0.7$ and $\Delta F < 1\%$, using CCPS instead of PLS increased ΔG by 15%, whereas in the absence of a restriction ΔG increased by 20%. Increasing the number of parents reduced ΔF substantially, but only moderately reduced ΔG . For example, with $h^2 = 0.4$, $r_{pc} = 0.4$ and a fixed total test capacity, increasing the number of sires from 24 to 48 reduced ΔF from 0.036 to 0.011 and ΔG from 0.394 to 0.330. This study shows that the long-term genetic contribution theory can be used to balance ΔF and ΔG in animal breeding schemes within very limited computing time.

Key Words: Combined Crossbred Purebred Selection, Rate of Inbreeding, Genetic gain

21 Implementation of the genetic contribution theory to predict rates of inbreeding in livestock breeding programs. P. Bijma*¹ and J. A. Woolliams², ¹*Animal Breeding and Genetics Group, Wageningen University*, ²*Roslin Institute(Edinburgh), Roslin, Midlothian, UK.*

A general theory to predict rates of inbreeding (ΔF) in selected populations has recently been developed. The theory states that ΔF is proportional to the sum of squared expected long-term genetic contributions. Here we will develop predictions of ΔF for populations with BLUP selection and either discrete or overlapping generations, which demonstrates how the general theory can be implemented for practical livestock breeding programs. Implementation consists of three steps. First, expected genetic contributions are predicted using regression of contributions on breeding values. Second, the expectation of squared expected contributions is derived, which is a function of squared regression coefficients and genetic variances. Finally, a term is added to account for deviations of the variance of family size from Poisson variances. Predictions were accurate for schemes with up to 20 sires, even for ΔF as high as 0.120. With more than 20 sires, predictions showed an average relative error of -11%, which was small compared to the variance of ΔF between schemes. The rate of inbreeding increased dramatically with selection intensity. For example, with a heritability of 0.1, 20 sires (N_m) 40 dams (N_f) and 4 offspring per dam (n_o), simultaneously increasing the number of parents and the number of offspring per dam by a factor four ($N_m = 80$, $N_f = 160$, $n_o = 16$) increased ΔF from 0.0184 to 0.0210. This shows that, with respect to ΔF , selection intensity may be more important than the number of parents. Up to 83% of the selected sires did not contribute to the population in the long term because their descendants were not selected, indicating that BLUP selection is a waste of resources. The present methods enable the balancing of rates of gain and inbreeding, and are therefore an important aid to design sustainable animal breeding plans. Up till now, balancing rates of gain and inbreeding required computationally demanding stochastic simulation.

Key Words: rate of inbreeding, effective population size, selection

22 Estimation of non-additive genetic variances and maternal inbreeding depression in Canadian Herefords. M. Duangjinda*¹, T. Druet², I. Misztal¹, and K. Bertrand¹, ¹*The University of Georgia, Athens*, ²*National Fund for Scientific Research, Brussels, Belgium*.

Genetic models for beef evaluation currently include only the additive effects. With a wider use of MOET and possibly cloning in the near future, the non-additive effects may be too important to ignore. The purpose of this study was to consider a more complicated model including the effects of dominance and inbreeding depression. 522,065 records of weaning weight from Canadian Hereford were used to generate 5 samples of about 50,000 records each. Records were adjusted for age of dam. Average REML estimates of the additive, maternal, permanent environment, dominance and maternal dominance variances were 23.9%, 15.5%, 19.5%, 17.3%, and 2.0% of phenotypic variance, respectively. Correlations between additive and maternal for direct and dominance effects were -0.33 and -0.63, respectively. The estimated inbreeding depressions for direct and maternal effects were -0.51 and -0.14 lbs/1% increasing of inbreeding. Computations by REML were computationally intensive. Therefore, variance components with the same

model and data were estimated by Method R, which is less expensive but which statistical properties are mostly unknown. The method R estimates of the additive, maternal, permanent environment, dominance and maternal dominance variances were 24.4%, 16.2%, 17.2%, 16.2%, and 7.5% of phenotypic variance. Correlations between additive and maternal for direct and dominance effects were -0.30 and -0.48 respectively. To validate the results, estimates by REML and Method R were also obtained for simulated data with varying data sizes and the proportion of full sibs. Under no selection, the bias with both methods was less than 5% except that there was some confounding between the effects of additive-maternal and dominance-direct with a small number of full-sibs. Under intense mass selection, bias in REML remained small but increased to about 30% for some effects in Method R. The direct dominance effect may be an important source of variation particularly with a large number of full-sibs. The maternal dominance effect seems to be small and may be ignored. Method R is useful for estimation of variance components if the selection is at most moderate.

Key Words: Non-additive genetic estimation, Maternal dominance, Maternal inbreeding

DAIRY FOODS, GOAT SPECIES AND SHEEP SPECIES SYMPOSIUM Small Ruminant Dairy Research - Production

23 Past, present, and future perspectives of small ruminant dairy research. G.F.W. Haenlein*, *University of Delaware, Newark*.

The objectives of this paper are to review small ruminant dairy research in relation to the dimensions of the dairy goat and dairy sheep industries in USA and the world. At least 10 countries depend between 30 - 76% of total milk supply on goats and sheep. Leading is Greece producing 178 kg milk/person/yr with 61% from sheep and goats. Most developing countries need research, extension service and public support to improve productivity of goats and sheep, as their supply from all milk is <100 kg/person/yr, and annual yields average <100 kg milk/goat, <50 kg milk/ewe, making supplies of animal protein and calcium critically low. Statistical data on goat and sheep production for USA are not available, although the small population of DHIA tested US dairy goats averaged in recent years >700 kg milk/goat/yr; and some dairy sheep breeds may produce as much as 650 kg/yr. The need for more milk appears to be reflected in the dramatic increases of dairy goat populations during the last 20 years: 52% for the world, 56% for developing, 17% for developed countries, while sheep populations decreased by 3% for the world, by 6% in developed, but increasing by 14% in developing countries. Research has been sparse on the unique qualities of goat and ewe milk compared to cow milk. Much development work by various agencies has been devoted to reducing mortality and improving feed supplies in harmony with the environment, published mostly in various proceedings of scientific meetings, often not in English. Results have shown in many cases that dairy goats can be very profitable, even in developing countries with difficult climate and topographical conditions.

Key Words: Dairy Goats, Dairy Sheep, Small Ruminant Dairy Research

24 Effects of breed, management system, and nutrition on milk yield and milk composition of dairy sheep. D. L. Thomas, Y. M. Berger, and B. C. McKusick, *University of Wisconsin, Madison*.

The U.S. imported 28.3 million kg of sheep milk cheese in 1998. This indicates a potential for growth of the small domestic dairy sheep industry. A 300-head dairy sheep research unit has been established at our Spooner Agric. Res. Sta. European dairy sheep breeds of East Friesian (EF) and Lacaune are being evaluated. EF-cross ewes produced 92% more milk, 67% more fat, and 69% more protein per lactation than Dorset-cross ewes ($P < .05$). In addition, EF breeding resulted in heavier ($P < .05$) lamb body weights and more ($P < .05$) lambs produced per ewe compared to Dorset breeding. However, lambs of over 50% EF breeding had lower ($P < .05$) survival rates than lambs of 50% and lower EF breeding. The Lacaune evaluation currently is in progress. Three lamb weaning/ewe milking systems were compared: D30 - lambs weaned from ewes at 30 d of age, ewes milked twice per day from weaning; D1 - lambs weaned from ewes at 1 d of age and raised on milk replacer, ewes milked

twice per day from weaning; MIX - lambs separated from ewes overnight and ewes milked once per day in the morning from 1 to 30 d after parturition, lambs weaned at 30 d of age, ewes milked twice per day from weaning. Large ($P < .05$) differences among D30, D1, and MIX treatments were seen for lactation yields of milk (149, 240, and 205 kg), fat (7.4, 12.3, and 10.2 kg), and protein (7.9, 13.0, and 10.9 kg). Percentage lactation milk fat was less ($P < .05$) for MIX than for the other two treatments (4.65% vs. 5.02%) due to very low % milk fat (3.24%) from MIX ewes during the first 30 d of lactation. In another trial, D1 and MIX ewes were supplemented with 100 g/d of rumen bypass fat or not supplemented with fat. Fat supplementation increased ($P < .05$) % milk fat in D1 ewes but had no effect on MIX ewes. The MIX system is a good compromise system because some milk is obtained from early lactation and the ewes rear their lambs, however, a solution to the low % milk fat while ewes are rearing their lambs needs to be found. Ewes allowed daily grazing of a clover-grass pasture produced 13% more ($P < .05$) milk per lactation than ewes fed hay in drylot (222 vs. 197 kg).

Key Words: Dairy sheep, East Friesian, Lamb weaning systems

25 Genetic evaluation of yield and type traits of dairy goats. G.R. Wiggins*, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD 20705*.

Genetic evaluations of dairy goats are computed annually by USDA from records available through Dairy Herd Improvement (DHI) and the American Dairy Goat Association (ADGA). During 1999, 11,273 does were enrolled in DHI test plans used in genetic evaluations; 3784 does participated in linear appraisal programs, which was lower than the mean of 4285 does for the last 5 yr. For evaluation of yield traits, an animal model similar to that used for dairy cattle is used, but analysis is across breeds. Lactation records for the first six parities of does that were born since July 1973 and that kidded since January 1976 are edited within limits appropriate for goats, projected to 305 d, and adjusted for kidding age and month. Evaluations are computed for milk, fat, and protein yields and component percentages; an economic index for milk, fat, and protein (MFP\$) is calculated based on economic values for dairy cattle. A multitrait animal model is applied to 14 linear type traits and final score. Through canonical transformation, a single-trait calculation method is used. Annual genetic progress for does that were born during 1996 as a percentage of mean breed yield was lowest for Toggenburgs (-0.1, milk; 0.0, fat and protein) and highest for Saanens (0.9, milk and protein; 1.0, fat). Corresponding trend for type traits across breeds was 0.67 for stature; 0.37 for rump angle; 0.34 for teat placement; 0.22 for suspensory ligament; 0.20 for strength; 0.12 for rump width and fore udder width; 0.16 for teat diameter; 0.09 for rear legs; 0.06 for dairyness; 0.05 for final score; 0.02 for fore udder attachment; and 0.01 for udder depth. Two production-type indexes are computed by ADGA with 2:1 and 1:2 weightings for MFP\$ and predicted transmitting ability for final score. Genetic evaluations and information on

pedigree and yield (including individual test-day data) are available at <http://aipl.arsusda.gov>. Based on developments for dairy cattle, test-day data eventually will be used directly in a test-day model for genetic evaluation of yield traits.

Key Words: Goat, Genetic evaluation, Type

26 Nutrition for the high producing dairy doe. S. P. Hart*, E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.

Before milk can be processed, it has to be produced by the animal and nutrients are a major input both in quantity and cost for milk production. The lactating animal is efficient at mitigating most, but not all, of the effects of widely differing diets on milk quality. The NRC report on Nutrient Requirements of Goats was published nearly 20 years ago; hence, a considerable body of research remains to be considered in nutrition recommendations for goats. The greatest limitation in knowledge of feeding goats is an inability to predict intake. The concentration of nutrients required in the diet is affected by intake level. Dairy goats often consume 6% of their bodyweight as DM and may exceed 8%. Due to the high levels of intake, the minimum dietary CP concentration may be lower than for dairy cattle. Several studies have shown the efficacy of bypass fat sources for increasing energy intake and milk production in dairy goats. Three studies have failed to demonstrate effects of bypass protein on milk production of goats, in contrast to well-documented improvements with dairy cows. Limited evidence indicates that goats have a faster rate of passage of digesta which would increase ruminal escape of protein and ruminal microbial protein production, thereby mitigating protein as a limiting nutrient. Very little work has been done on the utilization of feed byproducts in goat diets. The use of a negative ion balance in the diet for prevention of milk fever has not been studied in goats. Beyond calcium and phosphorus requirements, there has been little mineral research with goats. Overall, our limits in knowledge of goat nutrition force us to extrapolate from other species, which may and may not be appropriate and to rely on anecdotal information. A current project to develop nutrient requirement expressions from recent goat research may improve our ability to feed goats and help identify

critical research needs, which is quite important due to limited support for goat research.

Key Words: Dairy goat nutrition, Goat milk, intake prediction

27 Milk somatic cells and lactation in small ruminants. M. J. Paape*¹, A. V. Capuco¹, A. Contreras², and J. C. Marco³, ¹USDA-ARS, Beltsville, MD, ²Universidad de Murcia, Murcia, Spain, ³Maria Diaz de Haro, Bilbao, Spain.

The milk somatic cell count (MSCC) is the basis for abnormal milk control programs. The current legal MSCC limit for bulk tank milk for small ruminants in the United States is 10⁶/ml. Milk somatic cell counts for goats are higher than MSCC for cows and sheep. Evaluation of 71 bulk tank samples from commercial goat herds indicated that 65% of the samples exceeded the legal limit. The MSCC for goats free from intramammary infection range from 200 to 2,000 x 10³/ml. Cell counts for sheep are similar to cows and range from 10 to 200 x 10³/ml. Neutrophils comprise the major cell type in milk from uninfected goats and constitute 45 to 74% of the MSCC compared to 2 to 28% for sheep and cows. The macrophage is the major cell type in milk from cows and sheep. Milk secretion in goats and sheep is apocrine in nature and cytoplasmic particles, similar in size to milk somatic cells, are normal constituents in milk. Concentrations of cytoplasmic particles in sheep milk average 15 x 10³/ml while goat milk averages 150 x 10³/ml. Therefore, in order to obtain accurate MSCC, only cell counting procedures specific for DNA should be used. While intramammary infection contributes significantly to increased MSCC for goats and sheep, non-infectious factors such as parity, stage of lactation, season and milk yield have been related to increased goat MSCC. Cell counts for uninfected mammary glands will average 200 x 10³/ml during the first 3 months of lactation and progressively increase to > 1,000 x 10³/ml during the latter months of lactation. For sheep, counts are highest during the first few weeks of lactation (500 x 10³/ml) and decrease to 30 x 10³/ml at the fifth week of lactation, which coincides with maximum milk production. Counts remain unchanged for the remainder of the lactation. A further clarification on use of MSCC in abnormal milk control programs for goat milk appears justified because of noninfectious factors that influence MSCC for goats.

Key Words: Goat, Milk somatic cell counts, Sheep

DAIRY FOODS, GOAT SPECIES AND SHEEP SPECIES SYMPOSIUM Small Ruminant Dairy Research - Milk Quality and Dairy Foods

28 Hydration of native and rennin-coagulated caprine caseins as determined by oxygen-17 nuclear magnetic resonance. A. Mora-Gutierrez*¹ and H.M. Farrell, Jr.², ¹Prairie View A&M University, CARC, Prairie View, TX 77446, ²USDA, ARS, ERRC, Wyndmoor, PA 19038.

The hydration of native and rennin-coagulated caprine caseins was investigated by oxygen-17 NMR and fitted by nonlinear regression analysis. A charge-charge interaction model was employed to analyze the transverse relaxation (1/T₂) data. Relaxation differences between reconstituted native and rennin-coagulated micelles of caprine caseins strongly suggest that important structural dissimilarities exist between these milk proteins that are due to differences in the ratios of α_{s1} - to β -casein. Variants of α_{s1} -casein had significant effects on caprine casein hydration. The differences were more pronounced in rennin-coagulated than in native caprine casein micelles. The rennin-coagulated casein micelles containing low α_{s1} -casein retain an open, highly hydrated structure, in comparison with the rennin-coagulated caprine casein micelles containing high α_{s1} -casein. Second virial coefficients (B_o values) derived from oxygen-17 NMR data suggest that the native caprine casein micelles containing high α_{s1} -casein exhibit strong interactions, whereas the native caprine casein micelles containing low α_{s1} -casein do not. The compositional differences were reflected in differences in the extent of aggregation during casein clotting by rennin. Our results demonstrate that alteration in casein composition can dramatically alter cheesemaking properties of milk.

Key Words: Caprine caseins, Water binding, Rennin coagulation

29 Seasonal changes in the chemical composition of commingled goat's milk. M.R. Guo*¹, P.H. Dixon¹, Y.W. Park², J.A. Gilmore¹, and P.S. Kindstedt¹, ¹Northeast Dairy Foods Research Center, University of Vermont, Burlington, ²Agricultural Research Station, Fort Valley State University, GA.

Production of goat's milk cheese in North America has been growing rapidly during the past several years. However, information about the chemical composition of bulk-collected goat's milk and its seasonal variation is limited. The objective of this study was to analyze the chemical composition of commercial goat's milk shipments for one year to provide fundamental information for cheese making and milk cheese yielding potential and pricing. Samples were collected weekly from bulk milk shipments to a commercial cheese company over 12 months, beginning in April, 1996, and analyzed for contents of total solids (TS), fat (F), lactose, crude protein, casein, non-protein nitrogen (NPN), ash, minerals, and specific gravity (G). Chemical composition of the goat's milk varied widely during the year. The contents of fat and TS decreased over the first 20 weeks from 3.6% and 12.7% to 3.0% and 11.3%, respectively, and then increased to peak values of 13.4% and 4.4% in January. Crude protein and casein contents also decreased over the first 20 weeks, from 3.5% and 2.7% to 3.2% and 2.3%, respectively, before increasing gradually to 3.8% and 2.9% in February. Changes in the content of lactose was relatively small compared with those of fat and crude protein. Lactose content reached the highest level (4.9%) during September and November. Ash content declined during the first 20 weeks from 0.82 to 0.78%, and then increased sharply to 0.9% by week 36 before decreasing sharply toward the end of this study. Calcium content decreased steadily from 0.16% to 0.14% before increasing to 0.16% by around week 40. It was found that TS content could be estimated using the equation:

TS = 0.13G + 1.41F + 4.28 (r²=0.94). SDS-PAGE analysis showed that the goat's milk contained very little α s1-casein.

Key Words: Goat's milk, Chemical composition, Seasonal variation

30 Is there a future for goat and sheep milk cheesemaking in the U.S.? Technical and research considerations. P.S. Kindstedt*, M.R. Guo, and P.H. Dixon, *University of Vermont, Burlington.*

Historically, goat and sheep milk cheeses have accounted for only a small percentage of the total cheese produced in the U.S. However, in recent years the demand for domestic goat and sheep milk cheeses has been increasing. Typically, these cheeses are artisanal or semi-artisanal in nature and targeted towards value-added niche markets. Strong market demand has created new opportunities for artisanal cheesemaking but has also created pressure to expand scale of production. At the farmstead scale of production, artisanal cheesemakers often lack well defined schedules for optimum acidity during manufacture, and well defined parameters for finished product composition (e.g., moisture, fat, salt, pH). As scale of production increases, the need to monitor and optimize acidity schedule and finished product composition to assure quality and safety becomes more acute. Thus, the development of analytical monitoring systems tailored to artisanal cheeses is an important technical hurdle that must be addressed as the industry grows. Integrating this analytical data into the artisanal practices of the cheesemaker and affineur, thereby combining the art of cheesemaking with the science of cheesemaking, is a further challenge. At larger scales of production, accurate prediction of the cheese yielding capacity of the milk to facilitate inventory control and pricing for producer payment becomes essential. To this end, a better understanding of the factors that influence the cheese yielding potential of sheep and goat milk (e.g., seasonal changes in milk composition, SCC, casein number) is needed to develop valid yield equations. In summary, the future growth of goat and sheep milk cheesemaking in the U.S. will depend in part on whether artisanal practices can be augmented with science-based management tools to enable better control of starter performance, product composition, milk quality and cheese yield. Such tools are well developed for the cow milk cheese industry but will need to be tailored for sheep and goat milk cheeses

Key Words: Goat milk cheese, Sheep milk cheese, Artisanal cheese

31 Freezing qualities of raw sheep milk for further processing. W.L. Wendorff*¹, ¹*University of Wisconsin, Madison.*

Raw whole ovine (sheep) milk was frozen at -15°C and -27°C and microbiological and physico-chemical properties were evaluated periodically.

Coliforms and total bacteria decreased at a faster rate in milk stored at -15°C than at -27°C. Acid degree values for milk stored at -15°C were significantly higher than that stored at -27°C. Samples stored at -15°C exhibited protein destabilization after 6 months of storage while those stored at -27°C were stable throughout the 12 month storage period. Frozen ovine milk was evaluated in several products including cheese, yogurt and whey protein concentrates. Products produced from milk frozen at -27°C exhibited good sensory and functional characteristics. Ovine whey showed a higher proportion of β -lactoglobulin, about the same proportion of α -lactalbumin and lower proportions of serum albumin and immunoglobulin than bovine whey. Ovine whey protein concentrate showed significantly better foam overrun, foam stability, and gel strength than bovine or caprine whey protein concentrates.

Key Words: Sheep, Milk, Whey

32 Proteolysis and lipolysis of goat milk cheese. Y. Park*¹, ¹*Fort Valley State University, Fort Valley, GA.*

Numerous varieties of goat milk cheeses are produced worldwide. Maturation or ripening of goat and other species milk cheeses is governed by an interplay of many different factors. Proteolysis and lipolysis are two major biochemical processes in the multifaceted phenomenon of cheese aging, which involves the occurrence of a variety of chemical, physical, and microbiological changes under controlled environmental conditions. Proteolysis of cheeses is influenced by several factors including plasmin, chymosin, protease from starter and non-starter bacteria, pH and moisture levels of the curds, storage temperature and time, salt content, salt-to-moisture ratio, and humidity. Primary factors affecting lipolysis in cheeses are fatty acid composition, lipolytic enzymes, lipolytic microorganisms, moisture, temperature, storage time, oxygen, and surface area, etc. Several analytical techniques have been used for quantitative measurement of proteolysis of goat and/or cow milk cheeses during ripening such as solubility of peptides and amino acids in various solvents or precipitants, liberation of reactive functional groups, various forms of chromatography, and different forms of electrophoresis. Lipolysis of goat milk cheeses and other dairy products has been estimated by acid degree value (ADV), acid value, peroxide value, thiobarbuturic acid value (TBA) and free fatty acid contents using HPLC. Recent reports have shown that goat cheeses had greater rates of protein degradation than cow counterparts, and that aging time and temperature synergistically elevated most of proteolytic and lipolytic indices in goat milk cheeses. This paper will further discuss proteolytic and lipolytic characteristics of goat milk cheeses.

Key Words: Proteolysis, Lipolysis, Goat milk cheese

DAIRY FOODS SYMPOSIUM

Milk Protein and Enzyme Nomenclature Biologically Active Peptides from Milk

33 Bioactive milk peptides: A perspective. D.A. Clare* and H.E. Swaisgood, *Southeast Dairy Foods Research Center, Dept. of Food Science, North Carolina State University, Raleigh.*

Bioactive peptides have been generated from a number of the major proteins found in bovine milk including α -lactalbumin, β -lactoglobulin, caseins, lactoferrin, and serum albumin. These peptides are typically produced by the hydrolytic reactions of digestive proteases and influence numerous biological processes evoking behavioral, gastrointestinal, hormonal, immunological, neurological, and nutritional responses. Several categories have been designated that include antimicrobial peptides, antihypertensive and antithrombotic peptides, calcium binding and transport peptides, immunomodulatory peptides, and opioid agonists and antagonists. Similar discoveries have been made using analogous human milk proteins for peptide production. Our discussion will review the current literature in this area and attempt to stimulate thoughtful consideration for their continued use and expanded development as a commercial product. Already, casein phosphopeptides are utilized as dietary and pharmaceutical supplements. Potentially, antimicrobial milk peptides could be added to food products and provide improved consumer safety. Eventually, these research efforts may impact the evolution of new therapeutic healthcare products for effective treatment of

conditions such as hypertension, thrombotic diseases, gastrointestinal infections, and/or immunological disorders.

Key Words: milk peptides, bioactive peptides, therapeutic peptides

34 Transgenic over-expression of bovine α -lactalbumin and human IGF-I in porcine mammary gland: effects on lactation and piglet growth and development. S.M. Donovan*¹, M.H. Monaco¹, G.T. Bleck³, J.B. Cook², M. Noble², W.L. Hurley², and M.B. Wheeler², ¹*Dept Food Sci & Human Nutr.*, ²*Dept Animal Sciences, University of Illinois, Urbana.*, ³*Gala Design, Sauk City, WI 53583.*

The first week postpartum is the period of greatest loss for U.S. swine producers, with most morbidity and mortality attributed to malnutrition and scours, and long-term growth potential can be permanently reduced by malnutrition or disease during the suckling period. Despite the benefit to be gained by improving lactation performance, little progress has been made in this area through conventional means. Thus, transgenic technology provides an important tool for addressing the problem

of low milk production and its detrimental impact on swine production. We have developed transgenic swine over-expressing bovine α -lactalbumin (α -LAC; two lines) and human IGF-I (four lines). α -LAC was selected for its role in lactose synthesis and regulating milk volume and oral IGF-I has been shown piglet intestinal morphology and digestive function. The IGF-I construct consisted of the IGF-I gene inserted directly behind the α -LAC signal peptide coding sequence to allow secretion of IGF-I into milk. Outcomes assessed were milk composition, milk yield (weigh-suckle-weigh), piglet growth and intestinal development. First parity α -LAC gilts ($n = 16$) had higher milk lactose content in early lactation and 20-50% greater milk yield on days 3, 6, and 9 of lactation than non-transgenic gilts ($n = 20$). Weight gain of piglets suckling α -LAC gilts was greater ($p = 0.03$) from d 9 and 21 postpartum than control piglets. IGF-I concentrations were 10-fold higher in colostrum of first parity IGF-I transgenic gilts ($n=3$) than non-transgenic gilts ($n=2$) and elevated milk IGF-I is maintained throughout lactation at levels which are bioactive in piglet intestine (~ 1 mg/L). Milk yield may also be enhanced in IGF-I transgenic sows on d 3 (5.4 ± 1.0 kg, $n = 4$) vs. nontransgenic sows (4.1 ± 1.2 kg, $n=3$). Thus, transgenic over-expression of milk proteins may provide a means to improve swine lactation performance.

Key Words: Milk, Pig, IGF-I

DAIRY FOODS SYMPOSIUM Lactobacilli

36 Therapeutic use of lactobacilli. G. Reid*¹, ¹Lawson Research Institute, London, Ontario, Canada.

For over 100 years, probiotics have been used as a means of enhancing intestinal health. In recent years, increased problems with antibiotic resistance, consumer demands for natural therapeutics and publication of excellent scientific evidence for probiotic efficacy, have brought this therapeutic alternative back into the limelight, albeit more slowly in North America. Carefully selected lactobacilli, bifidobacteria, streptococci and saccharomyces have been shown to reduce the risk of infection, as well as confer other health attributes, while oxalobacteria appear capable of preventing oxalate stone formation. Mechanisms of action involve primarily adhesion to surfaces and production of factors (bacteriocins, biosurfactants, acids) antagonistic to pathogens. The potential for probiotics has now been extended beyond the gut to the nasopharynx, skin and urogenital tract. At least two strains, *L.rhamnosus* GR-1 and *L.fermentum* RC-14, have proven ability to colonize the vagina and reduce the risk of infection. As urogenital and intestinal infections represent the largest burden of illness around the globe, serious funding for studies on probiotics is long overdue.

Key Words: Probiotics, Lactobacilli, urogenital

37 Metabolic diversity of lactobacilli. B. H. Lee*, McGill University, Agriculture-Agri-Food Canada.

Lactic acid bacteria (LAB) are intimately associated with food, feed, health and they are particularly involved in many fermentation processes of milk, meat and vegetables, etc. For this reason they have become established as a major target for modern biotechnological research and development. These bacteria form a diverse group of microorganisms, such as the genera, *Lactobacillus*, *Lactococcus*, *Streptococcus*, *Leuconostoc*, and *Pediococcus*, which are Gram-positive, nonsporulating, catalase-negative, acid/aero tolerant, and produce lactic acid as the major end-product of sugar metabolism. LAB contain no cytochromes, and thus energy production depends solely on substrate-level phosphorylation, mainly from carbohydrates. The dairy industry is a prime user of these organisms, representing about 20% of the total value of fermented foods world-wide. Milk can be fermented into well over a thousand products and thus the diversity makes a discussion of the metabolism complex. The mechanisms by which milk satisfies the requirements of LAB for free amino acids and fermentable sugars are the most complex and widely-studied. Recent developments in the application of molecular biology to LAB have shown that it could be feasible to engineer metabolic pathways to either enhance specific metabolic fluxes or to divert metabolites for the production of different or new end products. However, this engineering requires detailed knowledge of metabolism and regulation within the targeted organism. Among LAB lactobacilli

35 Antimicrobial activity of the multimeric form of human milk alpha lactalbumin. H Sabharwal* and J Zabriskie, Rockefeller University, New York, NY.

This study describes an alpha-lactalbumin folding variant from human milk with bactericidal activity against antibiotic resistant and susceptible strains of *Streptococcus pneumoniae*. The active complex precipitated with the casein fraction at pH 4.6 and was purified from casein by a combination of anion exchange and gel chromatography. Unlike other casein components the active complex was retained on the ion exchanger and eluted only with high salt. The eluted fraction showed N-terminal and mass spectrometric identity with human milk α -lactalbumin, but monomeric, native α -lactalbumin had no bactericidal effect. Native α -lactalbumin could be converted to the active bactericidal form by ion-exchange chromatography under conditions used to isolate the active molecule from human milk casein. Analysis of the antibacterial spectrum showed selectivity for streptococci; Gram negative and other Gram positive bacteria were resistant at the concentrations tested.

Key Words: Human milk, Alpha lactalbumin, Bactericidal activity

are the most frequently involved in food fermentation processes, many of which are applied on an industrial scale. This seminar will examine some of the major research achievements that have contributed to our present knowledge of lactobacilli on metabolic diversity. Up-to-date examples will be given on plasmid or chromosomally encoded functions on hydrolyses and metabolisms of proteins/amino acids, carbohydrates, lipids/fatty acids, citrate, while it links to the synthesis of bacteriocins, exopolysaccharides, and pigments, etc. The genetically engineered lactobacilli could also produce various heterologous proteins.

Key Words: metabolism, diversity, lactobacilli

38 Bacteriocins from *Lactobacillus* as future food preservatives. M.L Chikindas*, J. Cleveland, and T.J. Montville, Rutgers, The State University of New Jersey, New Brunswick.

Lactobacillus is a lactic acid bacteria (LAB) which has for centuries been associated with foods, either as spoilage or fermenting/processing organisms. Bacteria produce small peptides, called bacteriocins, which mainly kill closely related organisms and help the host survive and establish an ecological niche. As few as 0.8% (ter Brink et al 1994) and up to 5% (Larsen et al 1993) of natural isolates of *Lactobacillus* produce bacteriocins. Bacteriocin-producing *Lactobacillus* are naturally present in many foods, including salad (Franz et al 1998), cheese (Ennahar et al 1996), dry and fermented sausages (Enan et al 1996, Palacios et al 1999), etc. Most bacteriocins kill sensitive cells due to the dissipation of the proton motive force, ATP depletion and leakage of small ions and molecules from the cell (Montville and Bruno 1994). Although bacteriocins are highly active antimicrobial molecules, they are not antibiotics. Based on their structure, bacteriocins are divided into four major groups (Klaenhammer 1988). Most of the characterized bacteriocins from *Lactobacillus* belong to class I or II. Bacteriocins from *Lactobacillus* inhibit foodborne pathogens in model food systems (DeMartinis and Franco 1998) or when the bacteriocin-producer is used as a competitive organism (Nilsson et al 1999) in food challenged with *Listeria*. Currently, nisin is the only LAB bacteriocin that is commercially used as a food preservative for decades in over than 50 countries. However, many bacteriocins from *Lactobacillus* are active against foodborne pathogens and food spoilage microorganisms, and stable over a wide range of environmental conditions. Therefore, in the future these molecules should be considered as food preservatives, especially when used as a part of hurdle technology.

Key Words: Bacteriocin, Food preservation, Lactobacillus

39 Effect of lactobacilli on cheese. K Nauth¹, ¹*Nauth Consulting Inc., Wheeling, IL.*

The process of manufacture of cheese of a given a composition is better understood compared to the development of characteristic cheese flavor, body and texture. Transformation of cheese curd to mature cheese involves microbiological shifts and complex biochemical inter-conversions at sub-optimal pH and temperature during ripening. It is generally agreed that during the cheese ripening process, the added starters (lactococci, streptococci and lactobacilli) disappear or are greatly reduced in numbers and the adventitious mesophilic lactobacilli become the dominant population. It is believed that these lactobacilli play a role in flavor development of cheese. Despite many attempts, the biochemical processes resulting in the positive impact of these lactobacilli on cheese are not well worked out. On the other hand, considerable progress has been made on understanding of the microbiological and biochemical as-

pects of cheese defects such as acid, slit defect, lactate crystals, fruity flavors, and biogenic amines production associated with these organisms. However, much of the information is from yester years when milk quality and subsequent handling and heat-treatment of milk varied from plant to plant. Due to food safety concerns, a large proportion of cheese is now produced from pasteurized milk. Such cheese has a different microbiological profile and a milder flavor. A fair amount of information on proteolysis and peptidolysis in cheese, or cheese slurry systems is discussed in literature but this alone is not sufficient to evaluate and qualify lactobacilli as adjuncts to cheese ripening. Research is needed to study and identify the role of naturally occurring or added non-starter lactobacilli and develop criteria for qualifying these as adjuncts for different cheese types.

Key Words: Cheese, Lactobacilli, Non starter lactobacilli

DAIRY FOODS SYMPOSIUM Educating Dairy Foods Scientists for the 21st Century

40 Educating dairy foods scientists for the 21st century. S. Duncan*¹ and K. Kaylegian², ¹*Virginia Polytechnic Institute and State University, Blacksburg,* ²*Wisconsin Center for Dairy Research, University of Wisconsin, Madison.*

Originally, dairy foods education was a primary commodity focus in food science departments and as part of dairy science departments. In contrast, the dairy foods education received today is often integrated into broader food science discipline courses. In many universities, there is no more than one dairy foods course offered, primarily at undergraduate levels, and usually offered as an elective. Graduates of food science departments are recruited by food companies providing more employment opportunities and, often, higher salaries than offered in the dairy industry. Recruitment of students for advanced Ph.D. programs is difficult when the food industry employment market is so strong. This situation raises multiple issues and concerns as we look to the future of the dairy foods industry and academic training programs to support the industry. Will we continue to motivate young scientists to enter dairy foods research and education fields? What can be done in dairy foods courses to stimulate and excite students into embracing a career in dairy foods? Will the focus be shifted primarily to the universities with dairy research centers to provide the depth of education needed for advancement of science in dairy foods? Can dairy foods faculty at non-dairy research centers maintain a focus in dairy foods research and education or must they diversify interest and focus to compete for research funding and internal support? Will universities continue to prioritize dairy foods positions and fill vacated positions with well-educated and trained dairy foods scientists? How will industry scientists achieve the depth of dairy foods knowledge needed if not attained in traditional dairy foods courses through the universities? Can distance education and industry short courses adequately fill the void? Now is the time to raise the questions and ascertain the future direction for dairy foods education and training. Five dairy foods academic and industry speakers will address these and other issues in a roundtable discussion with audience participation.

Key Words: Education, Dairy Foods, Issues

41 Issues of education for dairy foods scientists. R. Marshall*, *Department of Food Science, University of Missouri, Columbia.*

The discussion will reveal the issues under the headings of 1) quantity of graduates needed at the three degree levels, 2) quantities of students available for the educational programs, 3) content of the curricula at participating universities, 4) methods of teaching, 5) application of electronic technology to both teaching and industrial practice, 6) influence of the changing industry and 7) factors affecting locations of dairy industry facilities and of educational institutions involved in specialized discovery, education and service.

Key Words: education, dairy foods, issues

42 Successful teaching techniques in dairy foods courses. J. A. Partridge*, *Michigan State University, East Lansing.*

Students preparing for careers in the dairy and food industries need opportunities to develop interpersonal, computer, problem solving, and communication skills as well as technical competency in dairy foods. Dairy foods courses have traditionally offered a multidisciplinary framework for providing a successful learning environment. The application of classroom theory to realistic situations has been a product of knowledgeable faculty and strong dairy industry cooperation through site visits, guest speakers and internship/co-op programs. This paper will present examples of traditional problem solving and hands-on teaching models and examine the developing resources related to computer technology. The modern facilities at the Michigan State University Dairy Foods Complex will be used as the basis for demonstration of the commingling of traditional educational opportunities with modern process control and multi-media teaching resources. The examples will demonstrate the continued ability of dairy foods courses to be foundational learning experiences for both dairy and food science programs.

Key Words: Education, Dairy Foods, Students

43 Critical course topics needed for entry level industry opportunities. G. Muck*, *Dean Foods Company, Rockford, IL.*

Entry level jobs in food science will require courses in the basic sciences and additional courses in the foods area. The foods courses should include: food chemistry, food processing and food microbiology. Advanced courses in both the basic sciences and foods area would be beneficial. Knowledge of computers and management skills are also very desirable. Food processing is becoming more high tech all the time and new employees will have to be knowledgeable in the technology.

Key Words: Courses, Industry, Opportunities

44 Meeting the need through adult education short courses. R.L. Bradley*, *University of Wisconsin, Madison.*

Many university departments around the country offer short course programs. Basically all have been established to fill a need. Often these needs are suggestions from industry, regulatory or advisory groups. Meeting the instructional demand of these programs requires cooperation between university and industry experts. Further monitoring of course contents needs attention to keep subject matter updated and relevant.

From a dairy topics view, laboratory sessions are inherently valuable tools. Thus there is a demand to keep class sizes workable. Another possibility is to grant credit for these courses for undergraduates so that their basic program is augmented.

Key Words: Extension Education

DAIRY SPECIES SYMPOSIUM
Endocrinology and Metabolism in Transition Dairy Cows

45 The future of feed intake regulation research. C.A. Baile*, *University of Georgia, Athens.*

Understanding of the mechanisms involved in the control of food intake and regulation of energy balance has increased greatly in recent years, thanks in part to the discovery of leptin, an event that ushered in a renaissance in research in this field. Over the last 5 years, several other neuropeptides that affect food intake and energy balance have been discovered, including cocaine- and amphetamine-regulated transcript (CART), melanin-concentrating hormone (MCH), orexin/hypocretin, and agouti-related protein (AGRP). In addition, new roles have been defined for previously discovered factors, such as galanin and NPY, and the cytokines interleukin-1 (IL1) and tumor necrosis factor alpha (TNF α). These recent advances have been possible because of new technologies, including cloning, transgenics, genomics and bioinformatics. For example, positional cloning techniques have been used to identify the genes for these peptides and factors and their receptors. Knowledge about specific transcription factor binding motifs in promoter regions allows development of specific agents that alter gene expression. By using transgenic and cloning techniques, genes can be added or deleted, and transcription can be enhanced or suppressed to produce new animal models for studying interactions among factors. Over the next few years, the combination of microarray techniques and proteomics with sophisticated informatics tools will continue to provide fundamental insights into the complex physiological processes involved in feeding behavior and metabolism.

Key Words: Transgenic models, Proteomics, Feeding behavior

46 Changes in the somatotrophic axis associated with the initiation of lactation. M.C. Lucy*, H. Jiang, and Y. Kobayashi, *University of Missouri, Columbia.*

The change in nutrient metabolism that is required to support lactation in high producing dairy cattle is controlled by hormones that coordinate a variety of processes including the mobilization of fatty acids from adipose tissue and the synthesis of glucose from gluconeogenic precursors in liver. Growth hormone (GH or somatotropin) plays a central role in this process. The actions of GH are mediated by the GH receptor (GHR) and there are at least three alternative forms of the GHR mRNA in cattle (GHR 1A, 1B, and 1C). The GHR promoter 1 (P1) controls the transcription of GHR 1A mRNA. The primary location for GHR 1A mRNA is the liver of adult animals where GHR 1A represents the bulk of liver GHR mRNA. The binding of hepatocyte nuclear factor 4 (HNF-4) to GHR P1 may cause liver-specific expression of GHR 1A. The GHR P2 and P3 control the transcription of GHR 1B and 1C mRNA in a wide variety of tissues. The GHR P2 and P3 are 800 bp apart in the bovine genome and the activity of GHR P2 and P3 depends on an enhancer element that binds Sp1 as well as an unknown transcription factor. The presence of the common enhancer explains the similar pattern of expression for P2 and P3 transcripts (GHR 1B and 1C mRNA). The GHR 1A mRNA is different from GHR 1B and 1C because the mRNA amount is developmentally and nutritionally regulated. The liver GHR 1A is decreased at calving and then subsequently recovers during the early postpartum period. The decrease in liver GHR 1A mRNA in early lactation cows coincides with a period of liver refractoriness to GH when GH-dependent IGF-I synthesis and secretion are decreased. The activity of GHR P1 in periparturient cattle is independent from GHR P2 and P3 that control constitutive expression of GHR mRNA in liver. We hypothesize that the decrease in liver GHR 1A at calving leads to a decrease in the concentration of GHR in liver and a decrease in GHR second messenger signaling in early postpartum cows. Failure to regain GHR 1A expression during early lactation may compromise GH-dependent functions in liver and affect total milk yield.

Key Words: Growth hormone receptor, Bovine, Lactation

47 Adaptations of glucose and fatty acid metabolism in liver of dairy cows during the periparturient period. J. K. Drackley*, *University of Illinois, Urbana.*

Tremendous metabolic and endocrine adjustments must be made as dairy cows move from late gestation to early lactation. Requirements for glucose and metabolizable energy increase two- to threefold from

21 d before to 21 d after parturition. The liver must adapt quickly to provide the increased glucose needed to support high milk production, and to process the flood of NEFA taken up from extensive mobilization of adipose triglycerides. While the end results of these adaptations are well known, much less is known about the cellular and molecular mechanisms underpinning hepatic adaptation to lactation. Compared with activities present at 21 d before parturition, the capacity of liver tissue isolated at 1 d postpartum to convert alanine (an important gluconeogenic amino acid) to glucose increases more on a percentage basis than does gluconeogenic capacity from propionate. Likewise, hepatic abundance of mRNA for pyruvate carboxylase increases around calving, whereas mRNA for phosphoenolpyruvate carboxykinase (PEPCK) does not. Indeed, PEPCK seems to be more constitutive than adaptive in dairy cows, in contrast to rodents and other nonruminants. These changes in gluconeogenic enzymes suggest that amino acids from body and feed protein may be critically important sources of glucose for periparturient cows. Hepatic tissue from cows 1 d postpartum has greater rates of palmitate esterification, total and peroxisomal beta-oxidation of palmitate, and activity of mitochondrial carnitine palmitoyltransferase than hepatic tissue from the same cows 21 d prepartum. Prepartum nutrition has been shown to modulate some of these metabolic adaptations in the liver. Effects of hormones and cytokines that mediate adaptive responses to environmental and infectious stressors (or the lack of "cow comfort") have not been investigated. Techniques of modern biochemistry promise to make available new insights into the mechanisms of metabolic adaptation during the periparturient period, as well as to quantify the effects of nutrition and environment during pre- and postpartum periods on hepatic glucose and lipid metabolism.

Key Words: Liver Metabolism, Dairy Cows, Transition Period

48 Effects of monensin and growth hormone on glucose kinetics in the prepartum cow. A. Arieli*¹, J.E. Vallimont², G.A. Varga², and Y. Aharoni³, ¹*Hebrew University of Jerusalem, Rehovot, Israel*, ²*Pennsylvania State University, University Park*, ³*Agricultural Research Organization, Ramat Yishay, Israel.*

Additive effects of ionophores and hormonal growth promoters have been reported for daily weight gain in finishing steers but not for milk yield in dairy cows. This work examined the separate and combined effects of monensin and bST on glucose metabolism during the transition period in prepartum dairy cows. Fifty-five multiparous ad lib fed Holstein cows, were divided four wk before calving into 4 groups: control, monensin, bST, and combination of monensin and bST. During the prepartum period 300 mg monensin was top dressed daily to the total mixed ration, and 500 mg slow release bST (POSILAC) was injected on d 28 and 14 prior to calving. Glucose kinetics was assessed on day 18 prepartum from the decay curve of the enrichment of plasma C13-glucose injected in a single shot bolus, and fitted into a two-compartment model. Average DMI was 1.9% of cow's BW and was not affected by treatments. Blood glucose concentration was similar among treatments. There was no interaction between monensin and bST for any of the glucose kinetics parameters. Monensin supplementation was associated with an increase, and bST with a decrease, in glucose distribution space and glucose plasma pool size. Glucose flux between plasma pool and a secondary pool was reduced by monensin and was increased in bST cows. Fractional catabolic rate was decreased in bST cows and was increased by monensin. Yet, disposal rate of glucose was similar among treatments. Collectively, these data suggest that in prepartum cows bST and monensin have different and seemingly contrasting effects on pathways of energy partitioning. Results are in line with a positive effect of monensin treatment on the energy status of transition cows. Further experiments are needed to clarify the energetic benefit from combined monensin and bST treatment under a more severe energy deficit in the transition cow.

Key Words: bST, Monensin, Transition cow

49 Challenging a mechanistic model of dairy cattle metabolism to describe changes in body fat of high producing dairy cattle fed various diets during early lactation. J. Sage*, J. Phillips, T. Citron, and J. McNamara, *Washington State University, Pullman.*

The objectives of this work were: 1) to determine the effects of prepartum protein intake and amino acid balance on performance of cows in early lactation, and 2) challenge the behavior of an existing mechanistic model of metabolism in dairy cows for describing changes in body composition. Holstein cows (42) were fed two concentrations of protein for 28 days prepartum (11 and 14%) with or without 20 g/d liquid methionine hydroxy analog and then fed a common diet of 17% CP for 120 days postpartum. Daily feed intake and milk production were recorded. Body condition scores were measured and subcutaneous fat biopsies were taken from 31 cows at -14, +60, and +120 days about calving and the diameters of fat cells (FCD) were determined. Body fat (BF) and protein (BP) were calculated from FCD and BW using equations previously validated. Total dry matter intake for all cows averaged 25.4 kg (SD 3.1 kg) and milk production averaged 41.6 kg (SD 13.7 kg). Total protein prepartum was positively related to DMI and milk production postpartum ($P < 0.05$). Body fat and BP decreased from d -14 to d 60 by 51 kg and 8 kg, for the low protein group and 55.5 kg and 8.5 kg for high protein group. From d 60 to d 120 there was increase in BF of 8.5 kg and 11.5 kg for low and high protein groups and an increase in BP of 0.5 kg and 1.0 kg. A relationship between calculated BF and FCD ($BF = 1.39(FCD) - 43$; $R^2 = 0.73$) and between calculated BP and BW ($BP = 0.12(BW) + 12$; $R^2 = 0.99$) were shown. Fat cell diameter and BCS were related with a R^2 of 0.45 ($FCD = 19.57(BCS) + 40$). The model predicted 120d milk production within 2 to 7 % of observed. However, it over predicted milk prior to 60 DIM. This was accompanied by an over prediction of body fat and an under prediction of body protein. From 60 to 120 d of lactation the model described body fat and body protein changes much closer to observed values. More data on BF and BP turnover in early lactation are required to predict performance of transition cows.

Key Words: Transition, Body fat, Model

50 Indirect measurement of muscle protein degradation in lactating dairy cattle to challenge a metabolic model's ability to describe body protein usage. T. L. Citron*, J. J. Sage, J. G. Phillips, and J. P. McNamara, *Washington State University, Pullman.*

The behavior and sensitivity of a mechanistic model of dairy cattle metabolism was challenged for its ability to describe changes in muscle protein and muscle protein breakdown in early lactation. Holstein cows (42) were fed either 11 or 14 % CP diets for 28 days prepartum and a common 17 % CP diet from 1 to 120 DIM. Serum concentrations of 3-methylhistidine (3-MH) were determined as a qualitative indicator of muscle protein degradation. Postpartum dry matter intake of cows averaged 25.4 kg/d (SD 3.1 kg) and they produced a mean of 41.6 kg/d of milk (SD 13.7 kg). Animals consuming 14 % CP prepartum ate 0.7 kg/d more postpartum and produced 1.7 kg/d ($P < .05$) more milk. Body protein (BP) was calculated indirectly from body weight and fat cell size using previously validated equations. From d -14 to d 60, BP decreased an average 8 kg for the 11% CP treatment and 8.5 kg for the 14% CP treatment. From d 60 to d 120, BP increased .5 kg and 1.0 kg for the 11 % and 14 % CP groups. Serum 3-MH increased 1746 nmol/L (59%) from d -7 to 7 and then decreased 2155 nmol/L from d 7 to d 14 ($P < .05$), indicating an increase in BP breakdown. From d 14 to d 112, 3-MH was similar to prepartum levels. Nutrient composition, DMI, initial body weight, and body composition observations were explicit inputs into the model. The line bias, mean bias, and residual SD for the model prediction of milk production of cows fed the 11% CP diet were 2.03, .7, and 10.9 kg; and were .15, -1.5, and 4.6 kg for the 14% CP diet. The predicted change in BP from d 0 to d 60 was approximately 3-fold greater than the observed; however, from d 60 to d 120 predictions of BP were within the SD of the observed measures for both treatments. This research model described behavior of body protein use in early lactation as expected from available data, yet the sensitivity was inadequate, indicating better estimates of BP synthesis and degradation are required for model improvement.

Key Words: muscle protein breakdown, lactation, metabolic model

EXTENSION EDUCATION SYMPOSIUM A Dynamic Paradigm

51 Our evolving audience and their needs: The producer's perspective. H.D. Ritchie*, D.D. Buskirk, and S.R. Rust, *Michigan State University, East Lansing.*

As the structure of agriculture moves toward more tightly-aligned coordinated systems of production and marketing, producers are seeking information on selection of an appropriate system. They are asking the following questions: How well do the objectives of the system match up with my own? Is there good information flow in the system? What are the costs of joining? What attributes in my business am I weak on that can be enhanced by the system? Can I gain access to new technology? Can I secure financing and risk management assistance? Are specific management practices required, and what will it cost to implement them? Will I need to make a significant change in my genetics to fit the system's market specifications and will the new genetics fit my environment? Will I have an opportunity to intensify my management and focus on those aspects of my enterprise in which I am especially skilled? As animal agriculture becomes more consumer-driven, producers will be challenged to enhance product value while simultaneously controlling costs, as well as assuring animal well-being, integrity of the environment and food safety. Joining an appropriate coordinated system will better enable many modest-sized producers to meet these challenges and remain viable. It will be important for extension to play a role in their decision-making process.

Key Words: Coordinated Systems, Consumer-Driven

52 A multi-state approach to extension programming. A.J. Pescatore*¹, K.W. Koelkebeck², R.L. Adams³, C.J. Flegal⁴, A.H. Cantor¹, F.V. Muir⁵, M.A. Latour³, C.M. Parsons², M.W. Orth⁴, and K.D. Roberson⁴. ¹University of Kentucky, Lexington, ²University of Illinois, Urbana, ³Purdue University, West Lafayette, IN, ⁴Michigan State University, East Lansing, ⁵The Ohio State University, Columbus.

The poultry extension specialists at the University of Kentucky, University of Illinois, Purdue University, Michigan State University, and the Ohio State University have been operating a Multi-State Poultry Extension group for 15 years. This group has conducted and coordinated eight different multi-state extension educational programs and conferences for the poultry industry. These educational efforts have reached over 5,000 participants. The advantages of these multi-state programs are many. Larger audiences can be reached at one time which increases the efficiency of our individual educational efforts. The ability to attract extramural support for our programs has been enhanced. These additional resources enable us to maintain high quality programs in time of declining operational budgets. The multi-state effort also allows for more interactions with colleagues from other states and creates a critical mass of individuals to meet the educational needs of the poultry industry. There are some disadvantages or barriers to a multi-state program that must be overcome for this type of program to be successful. Increase travel and expenses can be expected for personnel to attend out of state programs. Additional resources must be provided to ensure participation of necessary personnel. There may be reluctance in a segment of the target audience to travel to another state. We have tried to overcome this by rotating programs from state to state. We feel that once people attend a program they will continue attending programs even in a different state. The traditional educational programs at a Land Grant University were delivered at the state and local level and many of the administrative procedures in place were developed for that structure. Existing procedures may be inhibitory to multi-state programming and

may need to be changed. Within a multi-state effort the personnel of various universities become interconnected. The staffing pattern at one university can impact the effectiveness of personnel at cooperating universities. The final barrier to multi-state programming is recognition of individual and institutional efforts. Our policy has always been that all individuals are identified for their efforts and no one institution dominates a program

Key Words: Multi-state programs, extension, poultry

53 Multi-state extension programming. S.P. Washburn*¹,
¹North Carolina State University, Raleigh.

Extension programs across state lines- frustrating or rewarding? Multi-state extension programming can be perceived as a threat because faculty may feel that jobs will be eliminated or that they will be asked to do more with less. However, multi-state extension program efforts can allow individuals the freedom to develop an expertise of particular interest and work in that specific area across state lines in contrast to general approaches in smaller areas. Industry clientele appear eager to embrace more regional approaches related to their commodity group interests. At the Southern Dairy Conference, a panel of 3 farmers and a cooperative manager recommended a regional approach to dairy extension, teaching, and research that would consolidate program efforts. The National Cattlemen's Beef Association and the National Pork Producers Council have also encouraged multi state programs. Factors needed to ensure effective multi-state extension programs include supportive administrations, complementary efforts, a cooperative local spirit, funding sources, and willingness to share credit. Ideas and program development need to start with faculty, including agents as field faculty. To facilitate such efforts, opportunities for informal sharing of ideas and team building must be encouraged. Multi-state agent and specialist retreats such as those hosted in recent years in North Carolina for dairy extension faculty have stimulated multi-state program efforts, including grant proposals, regional conferences, and agent training programs. Such retreats have given field faculty opportunities to share ideas and expertise and to be included on programs in other states. Workshops on national program efforts in swine and beef have also been effective in stimulating multi-state program efforts including professional swine managers conferences and a regionally shared exhibit and training program on improving beef production and quality. Portions of appropriated funding, privately funded programs such as producer check-off funds for education or research programs, and various grant opportunities need to emphasize regional components to further facilitate team building and innovative approaches.

Key Words: Programs, Multi-state, Teams

54 Responding pro-actively: Distance learning opportunities. K.K. Ragland* and G.L.M. Chappell, *University of Kentucky, Lexington.*

As the traditional audience of production agriculturalists diminishes, Extension educators are being asked to reach new and larger audiences of those who use agricultural products. Our on-demand society is also changing the way these clients expect to receive the information they want. Information providers like the Cooperative Extension Service are now expected to provide the specific fact or piece of data the client wants, at the time and place the client needs it, and in a format the client can use. For many, this is a completely new way of looking at

information and a tremendous challenge to our traditional delivery systems. However, it isn't an insurmountable challenge. Distance technologies provide us with many tools we can use to deliver information to new audiences in new ways. These media allow us to take any information, ranging from the generic to the personally-tailored, to an audience of one or millions, at one location or at every home computer, synchronously or asynchronously. The technologies available include traditional print materials, videotapes, satellite broadcasts, compressed video, Web pages, and on-line learning environments. Each of these media has its strengths and weaknesses, which means specialists need to be trained in the use of each so they can choose the right medium or, more often, mixture of media to reach a particular audience with a given message. Using these media to deliver information effectively is time-consuming, expensive, and requires a team approach. Consequently, Extension educators need to give extra thought to thoroughly defining an audience, designing appropriate materials for that audience, and building a delivery system that's not only effective, but sustainable. Distance technologies are a powerful set of tools, but, as with all new tools, an instruction manual and some practice are necessary to get the most from them. As new audiences demand more from Extension, many specialists will turn to these technologies, but clientele, faculty, and administrators need to understand that time, support, and experience will be necessary before specialists become as good at information delivery on-camera or on-line as they presently are face-to-face.

Key Words: Distance technologies, Extension, Audiences

55 The ADDS Center InfoBase: the technical aspects behind a multi-media information resource for agriculture. D.R. Beermann*¹, D.E. Boardman¹, M.B. Opperman¹, J.M. Mattison¹, and B.R. Eastwood², ¹ADDS Center, ²USDA-CSREES.

The Agricultural Database for Decision Support (ADDS) Center InfoBases present a versatile resource for distributing knowledge used to support decision making. Available over the Internet or as a CD-ROM, accessing thousands of resources is as easy as accessing a website or inserting a CD into the CD-ROM drive. The InfoBase presents a reasonable choice for professional publication of large amounts of information. Current InfoBases include Beef, Sheep, Pig, and Dairy, with other InfoBases in production.

Articles such as HTML pages, word processing documents, or PDFs can be converted for use in an InfoBase. Once added to the InfoBase, articles are formatted for aesthetic appeal. Depending on whether the InfoBase is viewed over the Internet or from a CD, two different procedures must be taken. Currently Folio[®] software is used for creating and searching InfoBases. For publication on a CD, the InfoBase must be "bound," a term Folio[®] uses for InfoBases ready to be published. A "bound" InfoBase cannot be altered or edited in any way.

Viewing the InfoBase from the CD requires that files must be installed onto the user's computer. To do this an installation program must be used (such as InstallShield) which will copy files onto the user's computer, leaving the InfoBase on the CD. This group of files includes a format of Folio Views meant only for viewing "bound" InfoBases and files associated with it. Content for the CD therefore includes the files necessary for viewing the InfoBase, the InfoBase itself, and the installation program. These files must be copied onto a CD, which will then be ready for distribution. Installation is user-friendly for agricultural field staff and producer use.

This technology provides quick and easy access to vast amounts of information, which can be used to support informed decision making for educators, producers and industry support personnel.

Key Words: InfoBase, Decision Support, Extension

FOOD SAFETY and DAIRY FOODS SYMPOSIUM Farm-to-Table Food Safety - Knowledge Gaps and Lessons Learned

56 Pre- and post-packaging strategies to achieve safety of ready-to-eat (RTE) meat products. S Knabel*¹, ¹Penn State University, State College.

A recent outbreak of listeriosis associated with consumption of contaminated hot dogs resulted in 101 cases and 15 deaths and heightened our awareness of this problem in RTE meats. *Listeria monocytogenes* is a psychrotrophic foodborne pathogen that can potentially grow to high

levels in RTE meat products during extended refrigerated storage. Contamination typically occurs in processing plants after thermal processing and before the product is sealed in a package. Control of this problem requires: 1) Insuring complete destruction of *L. monocytogenes* within the raw product during cooking; 2) Preventing contamination during packaging; and 3) Destroying or inhibiting any cells of *L. monocytogenes* that might have contaminated the product after thermal processing. Many potential sources of *L. monocytogenes* exist within meat and poultry

processing plants, including non-food-contact and food-contact surfaces. Preventing contamination after thermal processing requires isolation of the packaging room from the rest of the plant and identifying and eliminating sources of contamination, especially those within the packaging room. Microbiological testing for *Listeria* spp. should be used to identify both sources of contamination and critical control points, so that GMPs and HACCP can be effectively implemented to prevent contamination. Microbiological testing for *L. monocytogenes* should be used to verify the absence of *L. monocytogenes* in finished product. New and improved enrichment broths and rapid molecular methods would allow processors to more effectively screen for the presence or absence of *L. monocytogenes* in finished products. Since total elimination (0% risk) of post-processing contamination can never be assured, more research is needed on new strategies for destroying or inhibiting *L. monocytogenes* in packaged RTE meats, including the use of approved and new food additives and/or food irradiation.

Key Words: ready-to-eat meats, *Listeria monocytogenes*, control strategies

57 Emergence and transfer of antibacterial resistance mechanisms. David White*, *U.S. Food and Drug Administration, Washington, DC.*

There is currently increased public and scientific interest regarding the administration of therapeutic and subtherapeutic antimicrobials to animals, due primarily to the emergence and dissemination of multiple

antibiotic resistant zoonotic bacterial pathogens. This issue has taken center stage of late, yet, there is still no complete agreement on the significance of antimicrobial use in animals and/or resistance in bacterial isolates from animals on the development and dissemination of antibiotic resistance among human bacterial pathogens. In fact, this debate regarding antimicrobial use in animals and subsequent human health implications has been going on for over 30 years, initiated by the release of the Swann report in the United Kingdom. The latest report released by the National Research Council (1998) confirmed that there were substantial information gaps that contribute to the difficulty of assessing potential detrimental effects of antimicrobials in food animals on human health. Regardless of the controversy, bacterial pathogens of animal and human origin are becoming increasingly resistant to most frontline antibiotics, including third generation cephalosporins, aminoglycosides, and even fluoroquinolones. The majority of these antimicrobial resistant phenotypes are obtained by the acquisition of external genes that may provide resistance to an entire class of antimicrobials. In recent years, a number of these resistance genes have been associated with large, transferable, extrachromosomal DNA elements, called plasmids, on which may be other DNA mobile elements, termed transposons and integrons. These DNA mobile elements have been shown to possess genetic determinants for several different antimicrobial resistance mechanisms and may be responsible for the rapid dissemination of resistance genes among different bacterial genera and species.

Key Words: Antibiotic resistance, Transmissible elements, Zoonotic pathogens

FORAGES AND PASTURES AND RUMINANT NUTRITION SYMPOSIUM

Protein Nutrition in Forage-Fed Ruminants

58 Estimating forage protein degradation in the rumen. T. Klopfenstein¹, R. Mass¹, K. Creighton¹, and T. Patterson¹, ¹*University of Nebraska, Lincoln.*

Forage proteins are rapidly degraded by rumen microorganisms and therefore supply relatively small quantities of undegraded intake protein (UIP) to cattle. Young growing cattle with high metabolizable protein requirements and lactating beef or dairy cows responded to UIP supplementation when fed high forage diets, even though degradable intake protein (DIP) was adequate. Purines have been used for the past 15 years as a marker for microbial protein. Microbial protein must be accounted for in duodenal samples or in situ incubations in order to measure forage UIP. Recent reports suggested that the commonly used procedure has interfering compounds and that differential centrifugation may be inappropriate for obtaining clean samples of rumen microbes. Reanalysis of samples indicated 3 to 4 times the purine values in duodenal samples and in microorganisms attached to NDF incubated in situ. A modification of the in situ procedure is to remove the microorgan-

isms with neutral detergent solution after incubation. This procedure is highly correlated to the in situ procedure using purine correction for attached microbes, but it is less variable and simpler to perform. Enzyme analysis shows some promise as a procedure where ruminally fistulated cattle are not available. NIRS has been reported to be useful as a predictor of UIP by two groups but not by a third. Hopefully NIRS can be developed for commercial use, at least with monocultures. Rate of passage is used to calculate UIP values along with the in situ rate of degradation. We propose that passage lag time needs to be added to that calculation. Lag times may range from 5 to 15 h. Degradation with no passage markedly reduces UIP values. Forage proteins are highly degraded and for nutritionists to accurately balance diets for metabolizable protein, it is necessary to measure UIP values accurately. NDIN after in situ incubation appears to be a simple and acceptable method for UIP determination.

Key Words: Forages, Protein Degradation, Methods

GOAT SPECIES AND DAIRY FOODS SYMPOSIUM

Goats for Vegetation Management

59 Historical perspectives of using goats for vegetation management around the world. H. A. Glimp* and H. S. Hussein, *University of Nevada, Reno.*

The dietary preferences of foraging goats have been well documented by research at Texas A & M University and at other institutions in the U. S., India and in several African nations. Goats, with their prehensile lips, are capable of more aggressively foraging on shrubs and trees that may not be available to other species due to thorns, shrub density, and other aversive characteristics of the shrubs. Angora and other higher quality fiber goat breeds such as cashmere goats are usually managed in mixed shrub-grass plant communities, because the mohair and cashmere may become entangled in denser shrub communities. The Spanish goat type in the U. S. and Central and South America has historically been managed in shrub dominant plant communities for both vegetation management purposes and for meat production. In the developing world, numerous breeds of goats are kept for meat and milk production, and are considered salvage or by-product foragers as well as brush foragers. Prior to the last 10 years, the market value of Spanish goats was relatively low in comparison to other meat producing species, and these goats were kept primarily for brush control to enhance grass and

forb production for cattle and sheep grazing. In more recent times, we have learned how to take advantage of the selective grazing habits of the goat to achieve specific vegetation management objectives. Goats have been used to control invasive plant species such as Kudzu in the southeast U. S., leafy spurge and other invasive weeds in the western U. S., brush control at the wildlands/urban interface in California, and to control understory vegetation in tree plantations and national forests. In many situations, producers are being paid for vegetation management services.

Key Words: Goats, Vegetation Management, Grazing

60 Recent perspectives in using goats for vegetation management in the USA. Part I. S. P. Hart*, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Although an ever-increasing body of research data has documented the usefulness of goats for controlling brushy and weedy species such as shinnery oak, blackjack and post oak, leafy spurge, sericea lespedeza

and many others, this technology remains sorely underutilized. Environmental concerns and the increased costs of chemical and mechanical control methods provide greater opportunities to utilize biological control methods for brush and weeds that include goats. Goats have an advantage over other biological control methods in that they can profitably convert brush and weeds into a saleable product and they can be grazed concurrently with cattle. In addition, goats release the plant nutrients, especially N and P, that are tied up in brush and weeds to enable reestablishment of grassy species. The foremost limitation to using goats for brush and weed control is the social stigma cattlemen attach to goats. However, extreme economic pressures from invasive brush and weeds provide an incentive to overcome this prejudice. Extension demonstrations that provide visual proof of efficacy of control by goats are also valuable. The lack of an infrastructure (animal markets, source of large numbers of adapted animals, producer experience and knowledge base) to support goat enterprises is a serious constraint which is gradually being overcome by goat industry expansion. Suitable goat production systems need to be developed for specific environments. This involves the modification of existing knowledge, especially in regard to kidding date, parasite and predator control, electric fencing and marketing strategy. The lack of economic data and enterprise budgets is also a constraint. Further research is needed to collect economic data, and to develop stocking rate criteria and production systems to support the use of goats for biological brush and weed control.

Key Words: Goats, Weed and brush, Technology Transfer

61 Recent perspectives of using goats for vegetation management in the USA. Part II. E. C. Prigge* and W. B. Bryan, West Virginia University, Morgantown, WV.

The utilization of goats for the control of undesirable plant species has been studied by several experiment stations in the hill lands of the eastern United States. In all cases, in pastures with a high proportion (40 to 50%) of scrub species at the initiation of the experiments, the scrub species were reduced by half after the first year of grazing and almost completely eliminated after the second or third year. The number of years it takes for goats to limit brush on pasture to desirable levels is related to the scrub species infesting the pasture and grazing management. Studies at West Virginia indicated that preference indices for goats were always strongly positive for blackberry (*Rubus* spp.), moderately positive for grasses and varied strongly negative to moderately positive for greenbriar (*Smilax rotundifolia*), and strongly negative to strongly positive for legumes. Preference indices for greenbriar and legumes varied according to season and year, respectively. Research at several stations suggest the preference indices for multiflora rose (*Rosa multiflora*) would be high. Compared to sheep on brush infested pastures, goats will select diets higher in fiber and lower in CP content. Evidence suggests however, that goats may be able to digest these components to a greater extent than sheep. In West Virginia when goats were compared to mechanical brush control methods and herbicides, they were not as effective in the short term in reducing the proportion of brush. However, after five years brush cover was 2% or less with all methods. An economic evaluation indicated that goats are a more cost effective mechanism for clearing brush than cutting or aerial spraying.

Key Words: Goats, Brush Control, Grazing

GROWTH AND DEVELOPMENT SYMPOSIUM Molecular Mechanisms of Endocrine and Metabolic Action

62 Acetyl-CoA carboxylase- α (ACC- α): gene structure-function relationships. M. T. Travers* and M. C. Barber, Hannah Research Institute, Ayr, UK.

ACC- α is a key enzyme in the regulation of fatty acid synthesis and is subject to both acute control, via reversible phosphorylation, and chronic control which results in the regulation of synthesis of the enzyme. The gene for ACC- α is expressed ubiquitously but expression is highest in the lipogenic tissues; adipose, liver and mammary gland during lactation. These tissues demonstrate a metabolic adaptation to changing physiological demands, e.g. during lactation fatty acid synthesis in adipose tissue is markedly repressed resulting in the partitioning of lipogenic precursors to the mammary gland. Lipogenic tissues can also exhibit dysfunctions that result in excess fat deposition in farm animals and obesity in humans. In a tissue specific fashion. Transcripts from promoter 2 (P2) are present in all tissues whereas promoter 1 (P1) transcripts are principally restricted to adipose tissue. We have also identified an additional promoter (P3) which is also expressed in a tissue restricted manner. All three promoters are modulated by the physiological state of an animal suggesting that each promoter possesses enhancer domains that are targets for cell-specific signalling pathways and act in concert with the basal transcriptional machinery to regulate expression of the gene. Expression of the ACC- α gene is increased in mammary gland during lactation concomitant with the increase in the rate of fatty acid synthesis; in sheep this arises through induction of both P2 and P3 promoter activities. Conversely the ACC- α gene is repressed in sheep adipose tissue during lactation and this occurs primarily through inactivation of P1, although P2 activity is also repressed. Evidence suggests that this may arise in part from a change in sensitivity of the tissue to insulin. ACC- α will be presented with a view to determining the molecular basis of the modulation of expression of this gene in lipogenic tissues.

Key Words: Insulin, Mammary, Adipose

63 Regulation of the acid-labile subunit of the 150 kDa IGF-binding protein complex and its role in the circulating IGF system. Y.R. Boisclair*¹, G.T. Ooi², M.L. Tremblay³, R.P. Rhoads¹, and I. Ueki¹, ¹Cornell University, Ithaca, NY, ²Prince Henry's Institute of Medical Research, Clayton, Victoria, Australia, ³McGill University, Montreal, Canada.

In postnatal animals, most of insulin-like growth factor (IGF)-I and -II (IGFs) circulates in ternary complexes of 150 kDa composed of one molecule each of IGF-I or -II, IGF binding protein (IGFBP)-3, and an acid-labile subunit (ALS). Circulation of IGFs in 150 kDa complexes leads to their retention in the vascular system, prevents their hypoglycemic effects and is thought to promote their endocrine actions. Despite being the critical factor leading to the formation of ternary complexes, ALS has received only limited attention compared to the various IGFBPs and IGFs. We have performed studies in both mice and sheep in order to understand the regulation of ALS synthesis and its role in the circulating IGF system. First, we have cloned the mouse and sheep ALS genes and shown that they are organized similarly, with 2 exons and a single intron. Second, we have identified transcription factors binding to two proximal promoter cis-elements that are important to the basal and GH regulation of the mouse gene. We have broadened the relevance of these studies by showing that these two elements are conserved in the sheep and human ALS promoters. One interesting species difference is that ALS gene expression is increased after birth more rapidly and abruptly in the sheep than in the mouse. Finally, an ALS knockout model was created by inactivating the ALS gene in mouse embryonic stem cells. Mice that are homozygous for the mutation grow at a slower rate after birth. This growth depression is associated with large decreases in the plasma concentrations of both IGF-I and IGFBP-3, indicating the critical role ALS plays in regulating the circulating levels of these proteins. Studies of this model will lead to a better understanding of the role of ternary complexes in growth, development and diseases.

Key Words: Growth hormone, Transcription, Knockout

64 Insulin action and signalling in sheep adipose and mammary tissue. R. G. Vernon and E. Finley, *Hannah Research Institute, Ayr, Scotland.*

In contrast to rat, incubation in vitro of sheep adipocytes with insulin has little acute effect on the rate of lipogenesis. Prolonged exposure in vitro with insulin does have a marked effect on lipogenesis in sheep adipose tissue. Use of the inhibitor wortmannin suggests insulin increases lipogenesis via the phosphatidylinositol-3 kinase (PI3K) path in both rat and sheep adipocytes. Subcutaneous adipocytes were prepared from mature sheep by collagenase digestion and incubated with 100 ng/ml insulin for 15 min; this induced a 5-fold increase in PI3K and a 7-fold increase in protein kinase B (PKB) activity. PKB activation was assessed by serine phosphorylation of the kinase by Western blotting with an antibody specific for the phosphorylated form of the kinase. Insulin activation of PKB was rapid (within 2 min), sustained for 60 min and with a half-maximum effect with 0.3 ng/ml insulin. Thus insulin has similar effects on early signalling events in both rat and sheep adipocytes, so the lesion preventing acute activation of lipogenesis in sheep lies downstream of PKB. Mammary tissue is also refractory to insulin in sheep despite having insulin receptors. To test if these receptors are functional, lactating sheep were anaesthetized and biopsies of mammary tissue taken before and 2 and 15 min after intrajugular injection of insulin plus glucose. Serine phosphorylated PKB was present before injection of insulin and the amount of phosphorylation was not changed by injection of insulin. This suggests that the mammary insulin receptors in sheep are not functional or PKB is maximally activated by the low endogenous insulin of lactation.

Key Words: Adipose Tissue, Mammary Gland, Insulin

65 P27 Knockout mice response to growth hormone. H.B. Arnold*, D.L. Hartzell, X-L. Chen, and C.A. Baile, *The University of Georgia, Athens.*

A member of Cip/Kip family of CDK inhibitors, p27 is predominantly associated with cyclin D-CDK4, but has been shown to inhibit all known CDKs. Lack of p27/Kip1 induces general hyperplasia of tissues (gigantism), as well as marked hyperplasia in organs normally rich in p27/Kip1. Studies in mice have shown that p27/Kip1 knockout animals (p27^{-/-} and p27^{+/-} mutants) display increased weight gain compared to that of wild type littermates by 10 days of age, due to hyperplastic cell growth. Because growth hormone induces muscle cell hypertrophy, we hypothesized that p27 knockout mutants treated with growth hormone would exhibit both hyperplasia and hypertrophy, and therefore would show an increase in growth over that of vehicle-treated p27 knockout mice. We further hypothesized that in p27 knockout mice, levels of related CDK inhibitors, such as p21, might be elevated in response to enhanced tissue growth. In this study, we evaluated the effects of subcutaneously delivered porcine somatotropin (pST) on weight gain, feed intake, tissue weights and levels of p21 in fat tissue of p27^{+/-} mice. Eighteen 4-month-old, female p27^{+/-} mice were treated with pST (9 µg/g or 36 µg/g body weight), or vehicle (saline) for 7 days. Food intake and body weight were measured daily. After sacrifice, fat pads, organs, and selected muscles were removed and weighed, and a western blot analysis was performed to detect levels of p21 in fat tissue of mice given 36 µg/g pST or vehicle. Data analysis showed significant differences between p27 mice treated with vehicle, 9 µg/g pST, and 36 µg/g pST for cumulative food intake (24.17 g, 27.77 g, and 28.61 g, respectively) and weight gain (0.77 g, 2.89 g, and 3.47 g, respectively), but not for weights of excised tissues. Western blot analysis showed a non-significant difference in p21 expression level in adipose tissue of mice receiving vehicle and those receiving 36 µg/g pST. Our results indicate

that hyperplasia may not be involved in growth hormone-induced weight gain in p27 knockout mice.

Key Words: Mouse, P27 knockout, Somatotropin

66 Hepatocyte nuclear factor-4 may be responsible for the expression of the growth hormone receptor gene in liver. H. Jiang* and M. Lucy, *University of Missouri, Columbia.*

Transcription of the growth hormone receptor (GHR) gene in various species is controlled by multiple promoters. One of the alternative GHR promoters named P1 is responsible for the expression of a predominant GHR mRNA variant (GHR 1A mRNA). The GHR 1A mRNA is exclusively expressed in liver. Expression of GHR 1A mRNA in liver accounts for the high GH binding in liver relative to other tissues. The levels of GHR 1A mRNA in liver are positively associated with the blood concentrations of insulin-like growth factor-I (IGF-I) that is released from liver upon GH binding. Little is known about the mechanism for the liver-specific activity of the GHR P1 in any species. In the present study, using the DNase I footprinting analysis and electromobility shift assay, we identified a DNA element within the proximal GHR P1 in cattle that was specifically bound by the liver-enriched transcription factor hepatocyte nuclear factor-4 (HNF-4). Overexpression of HNF-4 increased the activity of the GHR P1 in Hep G2, PLC/PRF-5 and BHK-21 cells by 124.2%, 789.7% and 389.7%, respectively ($P < .01$). Overexpression of HNF-4 had no effect on the activity of the GHR P1 that was deleted with the HNF-4 binding site ($P > .10$). These results are the first demonstration of a transcription factor (HNF-4) that may be critical for the liver-specific activity of the GHR P1.

Key Words: Growth hormone, Receptor, Promoter

67 Mammary growth in Holstein calves: bromodeoxyuridine incorporation and steroid receptor localization. A. V. Capuco*¹, R. M. Akers², S. E. Ellis³, and D. L. Wood¹, ¹USDA-ARS, Beltsville, MD, ²Virginia Polytechnic Institute and State University, Blacksburg, ³Medical College of Georgia, Augusta.

Mammary growth in control and estrogen-treated Holstein calves was investigated. Calves were 3-mo of age. Four calves were injected once daily with estradiol-17β (0.1 mg/kg BW) and two control calves were injected with vehicle alone. Seventy-two hours after the initiation of treatment, calves were injected intravenously with bromodeoxyuridine (BrdU, 5mg/kg BW) and then killed 1 to 2 h later. Mammary tissue was collected at slaughter and processed for light microscopy. Serial sections of mammary tissue were used to generate 3-dimensional reconstructions of growing mammary ducts. BrdU-labeled cells were localized in the epithelium of mammary ducts and in stromal cells that were in proximity to ducts. BrdU-labeled cells were present in ducts that contained a lumen and in distal regions where the ductal outgrowths were solid chords of epithelium. Presumptive myoepithelial precursor cells along the basal portion of the epithelium also incorporated BrdU. Mammary cell proliferation was increased in estradiol-treated calves. Estrogen and progesterone receptors were localized in the nuclei of ductal epithelial cells. However, epithelial cells that were located in the central region of epithelial chords and those that lined the lumen of patent ducts were estrogen and progesterone receptor-negative, as were stromal cells and myoepithelial cells. The presence of estrogen receptor in bovine mammary epithelial cells but not stromal cells contrasts with the localization of estrogen receptor in murine mammary gland. Data suggest that the proliferative response to estrogen treatment was initiated within the epithelial compartment of the developing mammary gland and the signal was propagated in paracrine fashion to stromal elements.

Key Words: Estrogen Receptor, Progesterone Receptor, Proliferation

GROWTH AND DEVELOPMENT AND PHYSIOLOGY SYMPOSIUM

Appetite Regulation: Leptin and Beyond

68 Central action of leptin: effects on growth and reproductive performance. C.R. Barb*¹, R.R. Kraeling¹, and G.B. Rampack², ¹USDA, ARS, Athens, GA, ²University of Georgia, Athens.

The obese gene product, leptin, is expressed in adipose tissue, serves as a circulating nutritional signal and plays a role in regulating body

weight, energy expenditure, growth, and reproduction in several species such as the rodents and human. Information on the influence of leptin on appetite, energy metabolism and the brain-pituitary axis in domestic animals is limited. In the pig, leptin pulse frequency decreased by hour 24 of a 28 h fast with no change in subcutaneous back fat thick-

ness and plasma glucose and serum insulin concentrations were lower in fasted animals compared to fed controls. Metabolic fuel restriction in ovariectomized (OVX) prepubertal (P) gilts increased GH secretion, but decreased LH secretion. However, serum leptin concentrations and hypothalamic leptin receptor expression were not changed. Thus, effects of acute energy deprivation effects on LH and GH secretion are independent of changes in the leptin axis. Serum leptin levels, hypothalamic leptin receptor mRNA and estrogen-induced leptin gene expression in fat increased with age and adiposity in the pig. This occurred at the time when feed intake plateaued, suggesting that leptin acted at the brain to modulate appetite in the growing pig. Intracerebroventricular (ICV) injection of leptin suppressed feed intake, but stimulated GH secretion in intact P gilts. Leptin stimulated GnRH release from hypothalamic tissue *in vitro*. ICV injection of neuropeptide Y (NPY), an orexigenic peptide, blocked the effect of leptin on appetite and suppressed LH, but increased GH secretion in the OVX gilt. Thus, the leptin/NPY axis is an important link between metabolic status and mechanisms regulating appetite, growth and neuroendocrine function.

Key Words: Leptin, Nutrition, Hormone

69 Porcine melanocortin type 4 receptor: cDNA cloning and quantitation of size-related differences in gene expression in the young pig. C.J. Dyer^{*1}, J.A. Carroll¹, K.J. Touchette², G.L. Allee², and R.L. Matteri¹, ¹USDA Agricultural Research Service Animal Physiology Unit, Columbia, MO, ²University of Missouri, Columbia.

The melanocortin type 4 receptor (MCR4) is a hypothalamic receptor signaling for appetite suppression when bound by its ligand, alpha-melanocyte stimulating hormone (α -MSH), a product of the pro-opiomelanocortin (POMC) transcript. The agouti-related protein (AGRP) is another hypothalamic hormone which acts as an antagonist, binding to MCR4 and thus blocking the appetite-suppressive effects of α -MSH. We have recently presented preliminary data on the regulation of AGRP expression in newly weaned pigs; however, concurrent data on the expressions of POMC and MCR4 are required to interpret the physiological significance of altered AGRP expression. A 245 bp cDNA was generated from porcine hypothalamic RNA by reverse-transcription-polymerase chain reaction (RT-PCR), using primers designed from the published human MCR4 sequence. The porcine MCR4 sequence was found to be 93% homologous to the corresponding human sequence, and was used to generate a cRNA probe for the following experiment. Fourteen-day-old nursing pigs were either crossfostered to another sow or weaned onto starter diets containing 0 or 7% spray-dried plasma (n = 8/group). Piglets were further allocated by size into small (3.5 - 4.3 kg) and large (4.6 - 5.7 kg) groups. Piglets were sacrificed 4 days later for tissue collection. Hypothalamic MCR4 and POMC mRNA levels (relative to 28S rRNA) were evaluated by slot-blot hybridization. Hypothalamic POMC mRNA levels did not differ between weaning strategies or size (P > .1). MCR4 gene expression was higher in large pigs compared to small pigs (.482 \pm .036 vs. .331 \pm .023, P = .0025), but expression did not differ among weaning groups (P > .3). These data represent the first characterizations of MCR4 gene expression in a livestock species, and provide new information regarding a potentially important appetite-regulating pathway.

Key Words: pig, appetite, growth

70 Feed intake and serum GH, LH, and cortisol in ovariectomized (OVX) gilts after intravenous (iv) or intracerebroventricular (ICV) injection of urocortin (UCN). N. C. Whitley^{*1}, C. R. Barb², R. R. Kraeling², G. B. Rampacek³, J. B. Barrett², and D. H. Keisler¹, ¹University of Missouri, Columbia, ²ARS-USDA, Athens, GA, ³University of Georgia, Athens.

Gilts were ovariectomized and fitted with an ICV cannulae prior to experimentation to determine the effect of ICV or iv injection of UCN on feed intake and serum GH, LH, and cortisol (CS) in pigs. Pigs were fasted 20 h before injection at 0 h and allowed access to feed beginning 30 min after ICV injection of 5 (n = 4) or 50 (n = 3) μ g/pig UCN or saline (n = 3) in Experiment (Exp) 1 or after iv injection of 5 μ g/kg BW UCN (n = 3) or saline (n = 4) in Exp 2. Feed intake was measured at 1, 2, 3, 4, 5, 6, 8, 10, 12, 24, and 48 h after treatment. Blood was collected via jugular cannulae every 15 min from -2 to 6 h relative to treatment for analysis of serum GH, LH, and CS via RIA. In Exp 1, feed

intake decreased from 4 to 48 h for U50 vs S (P < .03), but was not altered by U5 (treatment by time interaction; TxT, P < .0002). Serum concentrations of CS were influenced by a TxT interaction (P < .001). Compared to -2 h, U5 and U50 increased (P < .02) CS, while S had no effect. Serum GH and LH were influenced by TxT interactions (P < .0002), with GH greatest (P < .05) at 1, 2, 3 and 4 h for U5 and at 1, 2, and 3 h for U50 vs -2 h. Serum LH declined (P < .02) following U50 (for all 6 h after treatment vs -2 h) but was not influenced by U5 or S. In Exp 2, iv UCN treatment resulted in slightly increased (P < .03) intake at 48 h (TxT, P < .05). Compared to -2 h, UCN increased (P < .03) concentrations of CS at 1, 2, and 4 h (TxT, P < .001). Serum GH was greater (P < .05) at 1, 2, 3, 4, and 5 h after S relative to -2 h, and was dramatically greater (P < 0.0002) at 3, 4, and 5 h after UCN treatment vs -2 h, with greater (P < .002) concentrations at 3, 4, and 5 h vs S (TxT, P < .0002), but mean LH was not influenced by iv UCN treatment. These data provide further evidence that ICV UCN modulates GH, LH, and CS secretion and suppresses feed intake in the pig and also indicates that iv UCN injection influences GH and CS in the absence of changes in feed intake.

Key Words: Urocortin, Feed intake, LH

71 Effects of lipopolysaccharide (LPS) on appetite-regulating gene expression in neonatal pigs. R.L. Matteri^{*}, J.A. Carroll, and C.J. Dyer, Animal Physiology Research Unit, Agricultural Research Service, USDA.

Depressed appetite is a well-recognized consequence of infectious disease. The primary objective of this study was to evaluate the effects of LPS injection on expression of hypothalamic appetite-regulating genes: orexin, neuropeptide-Y (NPY), agouti-related protein, pro-opiomelanocortin, melanin-concentrating hormone, leptin receptor, and type 2 orexin receptor. Interleukin 1 β (IL-1 β) mRNA levels were also determined to confirm a hypothalamic response to LPS. A secondary objective was to determine whether indomethacin (IND) might influence any effects of LPS. We have previously reported that IND prevents sickness responses to LPS injection in neonatal piglets (*J. Anim. Sci.* 77(Suppl 1): 35, 1999). Ten mg IND/kg or vehicle (0.1 M Na₂CO₃) was administered i.p. one hr prior to i.p. injection of 150 μ g LPS (0111:B4, Sigma Chem. Co.) or sterile saline. Forty-one piglets were utilized at 1 d of age (LPS, n = 11; IND, n = 9; IND + LPS, n = 11; Control, n = 10). Piglets were injected with IND or vehicle while still with their sows. One hr following IND the animals were quickly moved to a pen contained in an 18°C environmental chamber and injected with LPS or saline (time 0). Animals were sacrificed for tissue collection 3 hr after the LPS challenge. Specific mRNA levels in hypothalamic tissues, determined by slot-blot hybridization, were expressed relative to 28S rRNA. LPS injection significantly increased IL-1 β mRNA (107 \pm 4.1 vs. 92.9 \pm 4.7, P = .03), but concurrently depressed orexin mRNA levels (90 \pm 4.5 vs. 111 \pm 7.1, P = .019). Levels of NPY mRNA tended to be lowered following LPS exposure (P = .07). Pretreatment with IND did not influence LPS-induced changes in hypothalamic IL-1 β or orexin mRNA levels. The reduction of orexin mRNA subsequent to LPS injection is consistent with an expected decrease in appetite during infectious disease. Interestingly, the ability of IND to prevent LPS-induced sickness responses in neonatal pigs is not associated with analogous effects on present measures of hypothalamic gene expression.

Key Words: LPS, Piglet, Appetite

72 Nutritional regulation of circulating leptin in growing lambs is influenced by sex. R.A. Ehrhardt^{*1}, R.M. Slepatis¹, A.W. Bell¹, D.J.R. Cherney¹, M.E. Van Amburgh¹, and Y.R. Boisclair¹, ¹Cornell University, Ithaca, NY.

Circulating leptin concentration in rodents and humans is regulated by nutrition and exhibits sexual dimorphism but interaction between these factors has not been reported. Until very recently, sensitive and specific radioimmunoassays (RIAs) for leptin in ruminants were not available, thus precluding valid measurement of the effect of nutrition and other factors on circulating concentration. Therefore, our objective was to examine plasma leptin concentration in ram and ewe lambs fed diets that differed in energy and protein density, using our recently developed RIA for sheep and cattle leptin. Starting at 11-14 weeks of age, weaned Finn x Dorset lambs (19-27 kg body weight) were offered ad libitum levels of diets consisting of either high energy and high protein (H/H) (2.8

Mcal ME/kg DM, 18% CP), low energy and high protein (L/H) (2.1 Mcal ME/kg DM, 18% CP), high energy and low protein (H/L) (2.8 Mcal ME/kg DM, 12% CP), and low energy and low protein (L/L) (2.2 Mcal ME/kg DM, 12% CP) for a six week period (n=4 ram and 4 ewe lambs/diet). Weekly blood samples were obtained by jugular venipuncture for measurement of plasma leptin. Leptin concentration (5.7±0.3 ng/mL) in week 1 did not vary according to diet or sex. Sex had a significant influence on leptin concentration over the treatment period as leptin concentration increased at a greater rate in ewe lambs (P<0.001) than in ram lambs resulting in higher levels in ewe lambs (10.1 ng/mL) than in ram lambs (7.1 ng/mL) during week 6 of treatment. Plasma leptin was also influenced by nutrition over the treatment period as concentration in lambs fed high energy diets increased at a greater rate (P<0.001) than in those fed lower energy diets, attaining concentrations of 10.3 ng/mL (H/H and H/L) and 6.9 ng/mL (L/H and L/L) at the end of the treatment period. Differences between sexes also existed in this dietary response as leptin concentration in ewe lambs fed high energy diets increased at a greater rate than in ram lambs fed the same diets (P<0.005). We conclude that both nutrition and sex have important influences on circulating leptin levels in growing lambs. These effects may be explained in part by nutrition and sex related differences in body fatness.

Key Words: leptin, nutrition, sex

73 The effect of injecting LY355101, a leptin analog, on feed intake of finishing swine. A. J. Wuethrich^{*1}, D. L. Hancock¹, M. L. Heiman², J. D. Muegge¹, J. L. Roth¹, and D. B. Anderson¹, ¹Elanco Animal Health, ²Lilly Research Laboratories, Greenfield, IN.

Leptin is a protein produced by the adipose tissue, which has shown to have effects on feed intake, weight gain, reproductive performance, and immune function. Eli Lilly and Company has developed a leptin-like molecule, which has been shown to mimic the effects of leptin in rodents. A study was conducted to test the effect of a peripheral injection of LY355101, a leptin analog, on feed intake in swine. The goal of this experiment was to determine if LY355101 would have an effect on feed intake in finishing weight barrows. Forty-four barrows (85-90 kgs) were used in a randomized complete block design blocking on feed intake data taken over a 6-day allotment period. The barrows were housed individually in 6' × 10' pens in a fully enclosed facility with fully slotted floors. Animals were fed a 16% crude protein ration on an ad libitum basis for the duration of the trial. The treatments consisted of a sham injection and 3 levels of LY355101 (0.033, 0.1, and 0.3 mg/kg/day) injected twice daily for 10 days (injected intramuscularly in the neck region). Feed intake was monitored daily for 30 days (10-day treatment period and 20-day post treatment period). Body weights were taken on each barrow at 2-3 day intervals throughout the trial. A dose-dependent decrease in feed intake over the 10-day injection period was observed with treatment. Feed intake was reduced 14%, 20%, and 27% for dosages of 0.033, 0.1 and 0.3 mg/kg/day, respectively (P<0.01). As expected, average daily weight gain (ADG) and efficiency (G/F) were reduced by this compound. In the 20-day recovery period, G/F and ADG were higher in the treated animals compared with control (P<0.05). We conclude that peripheral administration of LY355101 reduces feed intake in a dose-dependent manner in swine.

Key Words: Leptin, swine, feed intake

74 Plasma leptin concentrations in dairy cows: II) Effect of feeding or postprandial infusion of canola oil. P.K. Chelikani^{*1}, J.D. Ambrose², D.R. Glimm¹, T.J. Kieffer¹, and J.J. Kennelly¹, ¹University of Alberta, Edmonton, Canada,, ²Alberta Agriculture, Food & Rural Development, Edmonton, Canada..

The role of leptin in the regulation of feed intake in dairy cattle has not been determined. Our hypothesis was that the depression in dry matter intake associated with fat supplementation might be mediated through leptin. Five Holstein dairy cows (BW 576±29kg; BCS 2.48±0.05; DIM 228±6), fitted with rumen and duodenal cannulas, were used in an incomplete Latin square design with 3 treatments: 1) Control: basal diet formulated to meet or exceed the NRC (1989) requirements for late lactation cows, with no added fat [C], 2) Control + abomasal infusion (18 h/d) of 1 kg/d canola oil [I] 3) Control + feeding canola oil at 1kg/d [F]. Each period was of 16 d with data collection in the last week of each period. Blood samples were taken at 0, 0.5, 1, 2, 4, 6, 8, 10 and 12 h after feeding on the last day of each period. Dry matter intake was reduced (P<0.01) by oil infusion (13.63±0.79 kg/d) compared to feeding oil (18.93±0.79 kg/d) or basal diet (17.56±0.89 kg/d). Plasma leptin concentrations were determined using the multispecies double antibody assay kit (Linco Research, St. Louis, MO) after validation. There were no differences (P<0.05) between treatments in plasma leptin (ng/ml) concentrations (C: 3.23±0.21; I 2.87±0.21; F 3.61±0.21), body weights (C 572.08±23.64; I 551.2±21.15; F 562.07±21.15 kgs), BCS (C 2.50±0.08; I 2.55±0.07; F 2.38±0.07), back-fat thickness (C 2.69±0.35; I 2.39±0.31; F 2.67±0.32 mm), weight (kg) of rumen contents (C 64.25±9.42; I 54.80±8.42; F 66.60±8.42), or evacuated body weight (C 502.0±21.93; I 479.40±19.61; F 491.60±19.61kgs). These data suggest that leptin may not be involved in the satiety effects of supplemental fats in dairy cows.

Key Words: Leptin, Canola oil, Dairy cows

75 Effect of energy balance on the concentration of plasma leptin in early lactating dairy cows. S.S. Block^{*1}, W.R. Butler¹, R.A. Ehrhardt¹, A.W. Bell¹, and Y.R. Boisclair¹, ¹Cornell University, Ithaca, NY.

In humans and rodents, plasma leptin concentrations are decreased during nutritional deprivation. In ruminants, study of the regulation of circulating leptin has been limited due to the absence of a valid assay. We used our recently developed bovine leptin radioimmunoassay (RIA) to study the impact of energy balance (EB) on leptin in dairy cows during the first 4 weeks following parturition. To create differences in net EB, cows were either dried off (n=7, NL) or milked three times a day (n=7, L) post calving. Lactating cows (L) developed a negative EB during the first week after parturition (-20 Mcal/day). This deficit was sustained and resulted in a significant decrease (P<0.005) in body condition score (BCS, -0.6 units) over the study period. Non-lactating cows (NL) were in positive EB during week 1 (+4.5 Mcal/day) and the remainder of the study with little change in overall BCS. Blood samples were collected during weeks 1 and 4, and analyzed for hormones and metabolites. When measured with our bovine RIA, L cows had lower plasma leptin than NL cows (2.8 vs 6.0 ng/ml, P< 0.01), with no indication that this difference increased over time. In contrast, when assayed by a commercial, non homologous assay (Multi-Species Leptin RIA, Linco Research Inc), plasma leptin did not differ between groups. Lactating cows also had lower plasma insulin (0.3 vs 1.9 ng/ml, P< 0.01), and glucose (33 vs 59 mg/dl, P < 0.01) and higher levels of non esterified fatty acids (NEFA) (218 vs 882 μmol/l, P<0.01). Concentration of leptin was positively related to concentrations of glucose and insulin (R²=0.6 for both, P < 0.01), and negatively related to concentration of NEFA (R²=0.4, P < 0.01). We conclude that EB regulates circulating leptin in early postpartum dairy cows. Our data also identify insulin, glucose and/or NEFA as candidates in mediating this effect.

Key Words: Leptin, Dairy Cows, Energy

GROWTH AND DEVELOPMENT AND PHYSIOLOGY SYMPOSIUM

From Genome to Function: Application of Genomics/Functional Genomics to Animal Agriculture

76 Commercialization of biotechnology in agriculture. C.A. Baile*, *University of Georgia, Athens.*

Powerful market forces are driving the applications of biotechnology in agriculture, including pre-farm gate and post-farm gate components of the value chain for agricultural products and world population growth. In addition, there is a growing demand in developing parts of the world for improved component quality of human foods, such as animal protein. These forces for increasing market volumes will put severe pressure on the efficiency of all agricultural production systems, including animal related products. Biotechnology is being used in the production of several commercial animal products, including chymosin for cheese production and bovine somatotropin for dairy cows. Somatotropins have also been approved in several countries for use in other species. There are many emerging applications for biotechnology in animals. Some of these are funded primarily by human medicine-driven applications, such as production of pharmaceuticals and organs for xenotransplantation by the use of transgenics and cloning of animals. These technologies will be further refined, and with the opportunity for large volume markets, will be available for economically viable commercial animal applications. The development of animal genomics, proteomics, informatics and related technologies will exponentially increase the opportunities for improving animal products. The timeline for these technologies to have an impact on the market place is open to debate, and in part, is dependent on the outcome of ongoing discussions of social, ethical, philosophical and economical issues. Many of the required discoveries have occurred and are available for development and commercialization.

Key Words: Biotechnology, Animal production, Commercial applications

77 Database management of high throughput EST sequencing and SNP discovery. J. W. Keele*, J. E. Wray, Jr., T. P. L. Smith, S. C. Fahrenkrug, E. Casas, B. A. Freking, and R. T. Stone, *U. S. Meat Animal Research Center, Clay Center, NE.*

A rough draft of the human genome sequence is expected by the end of 2001. Comparative maps between human and livestock genomes are expected to accelerate the development of technologies to improve production efficiency, product quality and food safety. Low-cost, high-throughput genotyping for a large number of single nucleotide polymorphisms (SNP) distributed across the genome is expected to increase the number of quantitative trait loci (QTL) that are detected and improve the effectiveness of marker-assisted selection. Progress is accelerated by database and bioinformatics technology capable of assimilating large volumes of data in heterogenous formats distributed across a computer network with minimal human intervention. The objectives of the work reported here were to sequence 80,000 expressed sequence tags (EST) for cattle and 40,000 for pigs, automate comparisons between livestock and human sequences, automate primer design targeting amplification of intron sequences and identify SNP. Expressed sequence tags are being generated from 6 normalized cDNA libraries (4 from bovine and 2 from swine). Libraries were derived from a mixture of tissues. Sequencing was done with a ABI 3700 DNA sequencer. Primer pairs were used to amplify products in a group of animals. Products were sequenced and scanned for SNP. Automation of BLAST and capturing results into a local database required minimal human intervention (< 1 intervention / 10,000 query sequences). The comparison of livestock EST with human genomic sequence using BLAST was used to predict the length and position of introns. Primers were designed flanking predicted introns using Primer3. Automation of the primer design process required minimal human intervention (< 1 intervention / 10,000 sequences). In conclusion, automation of analytical processes required for EST sequencing projects is feasible and facilitates increased throughput and more rapid progress.

Key Words: Bioinformatics, Database, Genomics

78 Dairy cattle genomics: Tools to accelerate genetic improvement? T.S. Sonstegard*¹, C.P. Van Tassell^{1,2}, and M.S. Ashwell¹, ¹Gene Evaluation and Mapping Laboratory, ²Animal Improvement Programs Laboratory, ARS, USDA, Beltsville, MD.

Traditional selection based on genetic merit calculated from phenotypic and pedigree information has been effective at improving production

in dairy cattle. Hypothetically, genetic improvement could be tremendously accelerated for yield and other economically important traits by directly selecting upon the genetic differences underlying the phenotypes. To elucidate these genetic differences, we have developed a research strategy based on Genomics to identify economic trait loci (ETL), and then DNA marker based tests developed for these ETL can be practically applied to enhance selection in a commercial setting. Initially, ETL have been detected in a US Holstein grandsire family using the granddaughter design and analysis of variance. Further genotypic analysis for two of these ETL have reliably identified milk and dairy form ETL on Chromosomes 6 and 27, respectively. Because the marker intervals identifying these ETL are not resolved well enough for accurate selection in current populations, we expanded the depth of our analyses to include an ongoing collection of animals from extended pedigrees. Increasing genotypic and phenotypic information alleviates the statistical limitations of ETL interval refinement inherent in the historic experimental population in two ways. First, the population size is not limited or biased by previous selection. In addition, the inheritance of ETL will be traced from historic families of interest to current generations relevant to the industry. After allele frequency and contribution to phenotype are determined in current populations, those ETL most beneficial for the industry can be accurately used for selection. As an aid to ETL mapping in dairy cattle, genes expressed in the mammary gland will be mapped and characterized to increase gene marker density near ETL and to identify genetic pathways important for animal production and udder health.

Key Words: Genomics, Gene Mapping, ETL

79 Sheep genomics: searching for genes involved in mammalian reproduction. S. M. Galloway*¹, K. P. McNatty², and G. H. Davis³, ¹AgResearch Molecular Biology Unit, Dunedin, New Zealand, ²AgResearch, Wallaceville Animal Research Centre, Upper Hutt, New Zealand, ³AgResearch, Invermay Agricultural Centre, Mosgiel, New Zealand.

DNA technologies are being used in association with extreme genotype selection for production traits in domestic sheep populations in N.Z. The DNA technologies have been applied to lines of animals selected for specific phenotypes to locate the chromosomal regions containing the genes involved, and to isolate the genes themselves. The key requirements are clear phenotypic measurements of the gene effect, family pedigrees in which the gene is segregating, DNA markers and a genetic map, and an understanding of the physiology underlying the phenotype. In order to carry out this work the AgResearch Molecular Biology Unit has led the development of the genetic linkage map of the sheep (<http://www.ri.bbsrc.ac.uk>) with international collaborators. The current map contains over 1000 polymorphic genetic markers. The map provides the ability to follow segregation of DNA markers within pedigrees and to identify chromosome regions that are consistently associated with particular phenotypes. We have focused particular attention to the Inverdale prolificacy gene (Fec XI). Inverdale is a major gene located on the sheep X-chromosome that affects follicular growth very early in development. The effect of the gene in heterozygous female sheep is an increase in ovulation rate by about one extra egg per ovulation and a consequent increase in litter size by an average of 0.6 lambs per ewe lambing. In contrast females homozygous for the gene have non-functional streak ovaries and are infertile. We have constructed a genetic linkage map of the sheep X-chromosome which spans 160 centiMorgans (cM) and mapped the gene to an 8 cM region near the centre of the chromosome. A diagnostic test using informative flanking markers is now being used to identify carrier sheep in research and commercial flocks. We aim to localise the Inverdale gene to a syntenic group conserved between species to identify potential candidate genes from the human and mouse X-chromosome mapping and sequence information. This paper provides an overview of the processes involved in identification of genes for productive traits in livestock and discusses current progress in the identification and characterisation of candidate genes for Inverdale.

Key Words: X-chromosome, sheep, ovulation

80 An FDA perspective on the regulation of genetic engineering in animals. J.C. Matheson*, *US FDA Center for Veterinary Medicine, Rockville, MD.*

FDA regulates the products of biotechnology, not biotechnology processes. Products of animal biotechnology are regulated according to existing product categories.

Animals are used as manufacturing sites for drugs, biologicals and diagnostics. The success of the biomedical industry has led to an increased use of large animal species that are also commonly used to produce food. These animals, which are sometimes transgenic, are used for producing immunochemical agents, like antibodies; biological agents, like vaccines; and to produce drug products in milk or blood (biopharming). Depending upon how the product is used, it may be regulated as a medical device, a biologic, or drug for humans or animals.

The use of food-producing species in the production of diagnostic kits and other biomedical products includes a special responsibility to plan for the ultimate disposition of culled animals, their offspring and meat, milk, and eggs from these animals. As a general matter, use of animals

from biomedical research or production facilities as sources of human food or as feed ingredients for other animals is considered by FDA not to be a safe means of disposition. However, FDA may consider specific requests for special circumstances.

Animals are also recipients of biotechnology products. Some biotechnology products for animals are designed to provide animal health or increased productivity benefits for animals and, therefore may require approved new animal drug applications. Some are designed to increase the nutrition value of food for humans or to change the functional characteristics of a food product derived from animals and may require approval as food additives.

These products work through genetic modifications, either by somatic cell therapy or by heritable germ-line modifications. Both types of genetic modifications are being investigated to change the structure or function of animals to improve animal health or increase productivity. In those cases, gene therapy and germ-line transgenics are simply additional methods to deliver animal drug products, like growth hormones.

Key Words: Biotechnology, Regulation, Animal drugs

HORSE SYMPOSIUM

Horse Programs in Animal Science – A Curse or a Blessing?

81 Impact of adding an equine major: Enrollment and cost effectiveness. D. Ames*, *Colorado State University, Fort Collins.*

The Department of Animal Sciences and College of Veterinary Medicine and Biomedical Sciences at Colorado State University established equine programs in 1946 and 1967, respectively. These programs were consolidated in 1982 and in 1986 an undergraduate major in equine science was approved. Although widespread support existed for the equine major, there were concerns that food animal majors would be reduced and resources would be diluted. Animal Sciences enrollment from 1970 to 1986 increased 3.7 percent (less than one-fourth percent per year) while total enrollment in the College of Agricultural Sciences declined. Since 1987 total enrollment in the Department of Animal Sciences has increased 69.2 percent (5.3 percent per year). During this same 13-year period, food animal and equine science majors have increased 92 and 48 percent, respectively. From an enrollment perspective it appears that the two majors form a symbiotic relationship and both have prospered. When percentage of resident instruction funds allocated for teaching food animal were compared with equine courses using credit hour production as a basis of comparison, equine courses became more cost effective while food animal courses were unchanged. In conclusion, adding an equine major in the CSU system increased enrollment of both food animal and equine science majors. Departmental cost effectiveness appears to be improved when the equine science major was added.

Key Words: Equine Science, Enrollment, Undergraduate Education

82 The relevance and importance of the equine sciences in contemporary animal sciences curricula. G.D. Potter* and P.G. Gibbs, *Texas A&M University, College Station.*

Historically, programs in the equine sciences have been conducted as a comparatively low priority in most departments of animal science. This was understandable following WW II, because the expansion of the modern horse industry didn't start until the mid 1960's. However, comparatively few departments of animal science developed priority equine sciences programs in response to the tremendous expansion of the horse industry. In those departments of animal science where surveys have been made, the majority of students indicate that the species of farm animal for which they have the most interest is horses. Consequently, faculties with equine expertise are challenged frequently with large enrollments in equine science courses. In general, equine research is comparatively under funded relative to the size, scope and significance of the equine industry. In the United States, the horse industry provides \$25 billion in goods and services annually, which is comparable to that of the motion picture and apparel manufacturing industries. There is an active horse industry in every state, and the industry has a \$112 billion annual impact on the U.S. economy. However, the horse industry is much more significant in some states than others, relative to other segments of animal agriculture. For example, horses and horse activities are woven into the social fabric of Texas where there are 288,000

households that own over 1 million horses. Cash receipts from sales of Texas horses rank behind only beef cattle and broilers among animal commodities, and are over twice the receipts received from sheep and swine, combined. The horse industry in Texas generates \$11 billion annually (approximately 15% of the agricultural economy of the State), which is larger than many traditionally viewed important areas of agriculture. Thus, the equine sciences are very relevant, and to attract students, meet their educational goals and meet the research and educational needs of a large segment of agriculture, the equine sciences should be a high priority component in many departments of animal science.

Key Words: Equine, Curriculum, Industry

83 The importance of international equine programs to animal science departments and colleges of agriculture. J. E. Shelle*, *Michigan State University, East Lansing.*

Because of the increased demand for students to have international experience, the Animal Science Department and College of Agriculture at Michigan State University (MSU) have developed a variety of international programs. Semester long programs provide the most extensive international experience, but are difficult to initiate and costly to maintain. At MSU it has been hard to get production oriented livestock students to commit an entire semester to study abroad. A number of such programs have been attempted in dairy and livestock in Animal Science, but have met with little success. By contrast, a semester exchange program for horse students between the Department and Enniskillen College of Agriculture in Northern Ireland has been full each semester and has a waiting list through 2002. It is thought that three factors contribute to the contrast in enrollment between livestock and horse related study abroad programs. First, US horse students have a great deal of respect for horse industries in other countries. Second, horse students come from more affluent backgrounds and have more money available for education. Third, horse students come from urban and suburban backgrounds and are more worldly by nature. It is difficult to verify if these are indeed the cause of such a discrepancy. The large enrollments in the Enniskillen Horse Program has provided revenue to continue to explore other avenues to increase international experiences for traditional livestock students.

Key Words: horse, international, teaching

84 Equine programs, an administrator's perspective. D.R. Topliff*¹, ¹*West Texas A&M University, Canyon.*

Equine programs as a part of colleges of agriculture are relatively new. In 1965, Rutgers University hired the first state extension horse specialist in the modern era and today equine programs are a common part of university agriculture programs. From the perspective of a former equine program leader and now agricultural administrator, equine programs are

no different than other ag programs in that they come with both positive contributions and challenges. Of the 440 undergraduate students in the Division of Agriculture at West Texas A&M, 75 (17%) are Equine Industry majors and an additional approximately 40 students identify themselves as pre-vet majors who intend to become equine veterinarians. Equine courses also attract students whose primary interest is another species or who are pursuing an unrelated major. This is particularly true of equitation courses. Students that become involved in equine programs may also have improved retention rates. Equine programs are expensive compared to some other types of programs. Most do not generate significant revenue through the sale of animals or products as do cattle, swine and dairy programs. To be effective, equine programs require extensive facilities that must be maintained to a higher degree than other live-

stock facilities. State and federal dollars for equine research programs are severely lacking and therefore, faculty in these programs may have difficulty in the promotion and tenure process. A bias against equine programs sometimes exists among other faculty members that do not understand a non-food animal industry. The opportunity for significant external funding from the industry does exist, but is often targeted toward facility development or given as in-kind support. In conclusion, these programs are expensive on the front end, but attract a significant number of students that generate credit hours and become supportive alumni.

Key Words: Equine programs, Undergraduate education, University priorities

INTERNATIONAL ANIMAL AGRICULTURE SYMPOSIUM

Converting Research to Application in Tropical and Subtropical Animal Production and Processing Systems

85 Developing collaborative research, education and extension programs among scientists in North and South America. A. Tewolde*¹, ¹Universidad Autonoma de Tamaulipas.

Issues such as globalization of the economy, environment preservation, and biotechnology developments will continue to have marked effect on animal production. The above imply the need for increases in levels and quality of production, and also for competitive and environmentally sound production systems. In Latin America this will mean generating systems compatible to the already ecologically fragile environment, and making them available to producers through extension programs. This will involve a revisiting existing research agenda and the basis for higher education using strategic alliance between institutions and Universities. In order to achieve the above, a proposal is made here to involve research for development, training and institutional building including all sectors associated with animal agriculture in the region. An example of this is the effective and productive agreement between a North Eastern

Mexican Technical Consortium in Agriculture and Texas A&M University (NEMTCA); after two years of existence, has involved a bottom up process including all parties in livestock mainly beef cattle, and its relationship with all the components associated with it in north east Mexico and south Texas, such as the range component, marketing of products and alternative uses of the range system. Scientists from both sides have been actively participating in looking critically at the same issues producing strategies and proposals that have clear vision to solving them. Four technical workshops on each component associated with beef cattle were held and recommendations generated from them served as the basis for the regional project that this joined has produced, incorporating producers and decision makers in its process. Based on this, a good program can be built on and proposed objectives can easily be achieved. Furthermore, the model NEMTCA can be applied to other regions of Latin American with the support of their professional organizations.

Key Words: Animal Agriculture, Strategic Alliances, Consortium

MEAT SCIENCE AND MUSCLE BIOLOGY SYMPOSIUM

Ante-mortem Manipulation of Meat Quality

91 Livestock handling quality assurance. T. Grandin*, Colorado State University, Fort Collins.

Careful handling of pigs and cattle at the slaughter plant will help preserve meat quality. Cattle handled quietly have less bruising and cattle which remain calm during handling are less likely to have dark cutting or tough meat. In pigs, quiet handling and a minimum of electric prod use in the stunning chute will reduce PSE approximately 10 percent. Meat damage from poor injection technique may be reduced in animals that are handled quietly. Proper injection technique is easier in calm animals. People manage what they measure. Objective scoring should be used to measure the quality of handling. Vocalization scoring can be used to assess handling quality. The percentage of cattle that vocalize (moo or bellow) during handling through chutes is tabulated. Other measures are the percentage of animals prodded with an electric prod and the percentage of cattle that walk quietly into a squeeze chute. Cattle that walk quietly into the squeeze chute are less likely to get shoulder injuries which cause extensive meat damage. Cattle that are handled quietly with a minimum of electric prod use will vocalize less than cattle that are excessively prodded with an electric prod. Squeal scoring can be used in pigs to assess handling quality. Several studies show that vocalization is correlated with physiological measures of stress in both cattle and pigs.

Key Words: Pigs and Cattle, Vocalization, Handling quality

92 Influence of nutritional therapy on meat quality. A.L. Schaefer* and P.L. Dubeski, Agriculture and Agri-Food Canada, Lacombe, Alberta, Canada.

Antemortem stress is a known factor contributing to poor meat quality in both beef and pork and is documented to cause meat quality aberrations including dark-firm-dry (DFD) and pale-soft-exudative (PSE)

meat as well as increased toughness. The objective of the current research was to test the effect of antemortem nutrition in modulating physiological insults which predispose animals to produce poor meat quality. Recent trials in both the USA and Canada on over four thousand head of finished beef cattle (2259 control and 2134 treated animals) demonstrated that animals treated with nutritional therapy products (USA Patents 5505968, 5728675) 18-24h pre-slaughter displayed a onefold to threefold reduction in the incidence of DFD ($P < .05$, Chi-squares test), an 18 to 20% increase in the retention of Prime and Choice carcass grades ($P < .05$, Chi-squares test) as well as a .6 to 1.0% increase in carcass yield ($P < .05$, analysis of variance). With swine, the primary effect of antemortem nutritional therapy appeared to be in carcass yield. Recent trials at the Lacombe Research Centre demonstrated a 1.1% increase in carcass yield in market weight hogs ($P < .05$, $n = 74$). These data suggest that antemortem nutritional therapy can be used to improve carcass yield and meat quality in cattle and hogs.

Key Words: Meat Quality, Nutritional Therapy, Antemortem

93 Vitamin E - A bridge between animal nutrition and meat quality. D. M. Schaefer*, University of Wisconsin, Madison.

The RRR isomer of α -tocopherol has the highest specific vitamin E activity. This isomer occurs naturally in plant and seed oils. Modern animal production systems, in which grain has replaced forage in diets, lead to diminished vitamin E intake. Supplemental vitamin E is typically provided as all-rac α -tocopheryl acetate. Following intestinal esterase activity, α -tocopherol is absorbed and deposited in nonpolar fractions of tissues, with apparent preference for the hydrophobic region of membranes. Meat lipid stability, in all species examined thus far, is enhanced during prooxidant challenge due to the antioxidant effect of α -tocopherol. Kinetic and chemical analyses indicated that α -tocopherol prolongs the induction period, which yields to uninhibited lipid and protein oxidation following oxidation of tocopherol.

Efficacy of vitamin E is greatest when its cellular placement results from several weeks of dietary ingestion. In cattle, muscle tocopherol concentration equilibrates with dietary intake in approximately 100 d. A visible meat quality benefit occurs in beef because oxymyoglobin stability is markedly improved. α -Tocopherol accounted for 63% and 81% of the variation in color display life in gluteus medius and longissimus, respectively. The most cost-effective implementation is feeding 500 IU of vitamin E per cattle daily for at least 100 d pre-harvest. No interaction with regard to color or lipid stability was detected for different combinations of dose and duration. This implementation protocol results in 2.5 μg α -tocopherol/g longissimus, which coincides with 3.1 μg /g neck muscle. The ratio of improved retail revenue to vitamin E expense is at least 10:1. It is estimated by industry sources that 1-2 million head of feedlot cattle are fed vitamin E annually to enhance quality of the resulting beef products at the retail level.

Beef from vitamin E-supplemented cattle is not a quantitatively important source of vitamin E in the human diet. Cooking to 65°C did not affect muscle α -tocopherol content. A serving of 84 g of beef containing 3 μg α -tocopherol/g would provide 3% of the RDA for women.

Key Words: Vitamin E, Color, Beef

94 Influencing beef tenderness through manipulation of calcium metabolism with vitamin D. J. B. Morgan and D. R. Gill, *Oklahoma State University, Stillwater.*

During the past ten years it has been substantiated that elevated intramuscular calcium results in enhanced postmortem muscle tenderization. Elevation of intramuscular calcium has been accomplished by: (a) direct marination of a calcium-containing solution, (b) infusing calcium into carcasses via the circulatory system, and (c) injecting calcium into beef primal cuts. In an attempt to elevate calcium levels in beef animal/cuts through dietary means, an initial project utilized 182 steers, in which animals received either 0 or 7.5 million IU of Vitamin D₃ (VITD) for 7 d immediately prior to harvest. Compared to longissimus muscle samples from non-supplemented (CON) animals, VITD supplementation significantly elevated intramuscular calcium levels (21.3 $\mu\text{g}/\text{g}$ versus 14.2 $\mu\text{g}/\text{g}$), improved longissimus tenderness (4.21 kg versus 5.13 kg) and displayed higher calpain proteolytic activities. In a second investigation steers (n=119) were divided into four dietary treatment groups: CON; VITD (6 million IU/animal/d for 6 d); vitamin E (VITE, 1,000 IU/d for 56 d prior to harvest); combination (COM, treatments VITD and VITE). Mean shear force values were highest for CON longissimus samples regardless of postmortem aging time. Regression analysis indicated

that steaks for VITD and COM required less time to achieve shear force values of ≤ 3.86 kg relative to CON and VITE treatments (7.4 d and 9.8 d versus 15.8 d and 11.8 d, respectively). Addition information indicated that VITE and COM steaks exhibited longer retail case life characteristics compared to CON and VITD steaks. In a third investigation it was determined that VITD supplementation (6 million IU/animal/d for 6 d) improved longissimus, gluteus medius and biceps femoris muscle tenderness as categorized by the percentage of cuts having shear force values ≥ 3.86 kg following postmortem aging. Results indicate approximately one-half (53.7%) compared to only one-fifth (19.8%) of the CON and VITD cuts, respectively, displayed tenderness values greater than this shear force tenderness threshold. To date, VITD supplementation appears to provide a unique approach to enhancing meat tenderness. Additional research is underway to further explain the exact mode of action of VITD supplementation on meat tenderness.

Key Words: Beef, Vitamin D, Tenderness

95 Does dietary conjugated linoleic acid improve meat quality? D. Beitz, *Iowa State University, Ames.*

Because of the numerous human health benefits, animal scientists have developed an intense interest in increasing the content of conjugated linoleic acid (CLA) in foods derived from animals. CLA, which consists of a mixture of positional and geometric isomers of linoleic acid, seems to (1) be an anticarcinogen, (2) have antiobesity and antiatherosclerosis activities, (3) stimulate immune response, and (4) normalize impaired glucose tolerance in animals models. Feeding supplemental dietary CLA to meat animals enriches meat with CLA. Loins from CLA-supplemented pigs have increased marbling and firmness and no change in color. Improvements in feed efficiency are often noted for pigs. Moreover, supplemental dietary CLA for laying hens and dairy animals significantly increases CLA content of eggs and milk. Recent research suggests that ruminants synthesize CLA in tissue via Δ^9 -desaturase activity in addition to formation of CLA in the rumen from dietary linoleic acid. Dietary CLA influences fatty acid composition (e.g., decreases proportion of monounsaturated fatty acids) of meat and milk through inhibition of desaturases at the level of transcription. Clearly, research on the benefits of CLA for humans will continue to stimulate future studies on use of CLA in animal agriculture.

Key Words: Conjugated linoleic acid, Health, Meat quality

MILK SYNTHESIS SYMPOSIUM

The Physiology and Economics of Alternate Methods for the Initiation and Maintenance of Lactation

96 Induced lactation in prepubertal Holstein heifers . S. Ball¹, K. Polson¹, J. Emeny¹, W. Eyestone¹, and R. M. Akers*², ¹*PPL Therapeutics, Inc., Blacksburg,* ²*Virginia Tech, Blacksburg.*

Lactation was hormonally induced in six prepubertal Holstein heifers using seven daily injections of estrogen and progesterone, three injections of dexamethasone on d 18, 19, and 20 following by twice daily hand milking beginning on d 21. Heifers were about 6 mo old and weighed 162 kg at the beginning of the experiment. Secretions were obtained from 5 of 6 heifers and twice daily milking continued for 75 d in 3 of 5 heifers. Volume of milk obtained on d 7 ranged from 32 to 500 ml and averaged 4.7, 4.1, and 3.7% lactose, protein, and fat, respectively. In first natural lactation, milk yield and composition was nearly identical for controls and induced heifers. Serum α -lactalbumin was increased in induced heifers after treatment with dexamethasone and was highest on d 10 after onset of milking. Our data suggest that sufficient secretions for extensive biochemical testing can be obtained following hormonal induction of lactation in a majority of prepubertal heifers. Moreover, hormonal induction of lactation had no apparent effect on reproduction or first natural lactation. While it is unlikely that hormonal induction of lactation in prepubertal heifers is practical from a dairy production viewpoint, the advent of biotechnology for production of therapeutic recombinant proteins in the mammary gland of transgenic livestock has made early detection of these transgenic proteins very desirable. We conclude that induction of lactation in prepubertal heifers is a viable

technique for testing the expression of mammary-linked gene constructs in transgenic cattle.

Key Words: Induced lactation, Prepubertal heifer, Milk composition

97 Induced lactation: physiology, perception, profitability and propriety. R.S. Kensinger*¹, ¹*Penn State University, University Park.*

Methods to induce lactation in non-pregnant dairy animals have been studied for decades. Justifications include the potential to save good quality cows, increase days-in-milk, allow for internal expansion and to increase farm profitability. General attributes of common experimental methods are estrogen-progesterone treatments to simulate hormonal concentrations observed during late pregnancy, followed by milking. Cows initially produce colostrum, and attain peak milk production more gradually than postpartum cows. Recent work by our group showed that bST augmented milk yields of induced cows, with a mean milk yield of 27.1 kg/d for 305 days. Fertility during induced lactation was good for most cows, with several in subsequent postpartum lactations. Heifers were also induced into lactation at 15 mo. of age. Milk production average 17.5 kg/d over 300 d, with 3.7% fat, 3.3% protein. Fertility, growth and health of induced heifers was good, and lifetime performance data will be collected. An economic comparison of inducing cows versus using conventionally reared replacement heifers included fair market values for costs and multiple component pricing for milk. Net present value for an induced cow was \$520 greater than that

for a heifer. Important, but unresolved issues related to this technology are public perception, FDA approval, and the proprietary nature of the technology.

Key Words: Induced lactation, Somatotropin, Economics

98 Effect of milking interval on mammary function and shape of the lactation curve. K. Stelwagen*, *Research Station for Cattle, Sheep and Horse Husbandry (PV), Lelystad, The Netherlands.*

Ultimately milk yield is a function of the number of functional secretory cells in the mammary tissue and the metabolic activity of these cells. Both the number of cells and the cell activity are not static, but change during the course of lactation. The rate at which both cell number and activity change may be influenced by farm management practices, such as feeding, photoperiod, hormonal treatment (e.g. BST), and milking frequency or interval. By applying such practices, or a combination thereof, at any time during the lactation the farmer has tools to alter the shape of the lactation curve. For instance, these practices could be applied following peak lactation to increase milk yield and perhaps slow down the rate of post-peak decline in milk yield, i.e. increase persistency, but can also be used to accelerate the post-peak decline to promote involution of the gland near the time of drying-off. The present review will focus on only one of these tools, i.e. milking frequency or interval. Compared to a standard twice-daily milking regime, milking three times a day or more often (robotic milking) will increase milk yield by approximately 15%, whereas going from twice to once-daily can decrease milk output anywhere between 10 to 50%. Although more frequent milking is practised more often than once daily, the once-daily milked gland provides an excellent model to study functional changes related to milking interval. The effects of increasing and decreasing milking frequency or milking interval on mammary function will be reviewed at the whole gland as well as at the cellular level, with the emphasis being on functional changes in the once-daily milked gland.

Key Words: Mammary Gland, Milking Interval, Mammary Function

99 Manipulation of lactation persistency with maintenance of milk quality. C. H. Knight* and A. Sorensen, *Hannah Research Institute, Ayr, UK.*

Declining milk yield after peak lactation is a consequence of loss of secretory cells rather than reduced activity per cell. Overall cell loss results from apoptosis in excess of proliferation. We conducted an experiment in dairy cows (n=12 per group) managed for 18 month extended lactations to examine effects of milking frequency (3X vs. 2X daily), nutrition (standard management vs. 3k/d supplementary concentrate) and calving season (winter vs. spring) on lactation persistency. Persistency was calculated for each cow as the slope of best-fit linear regression analysis

of daily milk yields from wk 9 (treatment start) to wk 33 (re-breeding start) and to gestation wk 20 (chosen to avoid the negative effects of late pregnancy). Analysis of variance/co-variance was used, with peak yield as co-variate. Persistency to wk 33 was significantly improved by 3X (P=0.03), by winter calving (P<0.001) and non-significantly by supplementary nutrition (P=0.07). Effects were additive. Persistency to gestation wk 20 was significantly improved only by 3X (-0.159 vs -0.19, SED 0.011, P<0.01). Casein number (a measure of milk processing quality) was maintained at its peak lactation value by the combined treatment of 3X and nutritional supplementation). In conclusion, simple management practices are available which will improve lactation persistency and maintain good milk quality.

Key Words: Lactation Persistency, Extended Lactation, Milking Frequency

100 Economics of atypical milk production. D. Galligan* and L. Lormore, *University of Pennsylvania School of Veterinary Medicine, Kennett Square.*

A dairy's economic vitality is dependent on the efficient management of variable and fixed costs associated with milk production. Management practices have evolved in response to the underlying biological life cycle of a cow to confer economic advantages to producers. Under current management practices, heifer rearing cost is commonly reduced by lowering age at first calving, thereby reducing the fixed costs of animal replacement over the remaining lifespan of the animal. By attempts to lower the calving interval (CI), the curvilinear attributes of the lactation curve are utilized to ensure a high level of average milk/day - thereby minimizing the cow's daily fixed maintenance cost over more pounds of product. A countering economic force encouraging longer calving intervals (C.I.) are the fixed costs associated with each lactation event (peri-parturient mortality and morbidity, breeding cost etc.). As these cost increase, it is desirable to spread them over more units of product by lengthening the C.I. New technologies, (induced lactation, elimination of the dry period, changing the shape of lactation curve) continually challenge traditional dairy production practices and present new atypical production possibilities. Technologies that induce lactation have the potential to dramatically reduce heifer-rearing cost and/or the fixed cost/lactation and, depending on the integrity of consequential production, change the herd's economic efficiency. Technologies that alter the shape of the lactation curve will minimize the disparity between early milk production and late production, thereby potentially changing the advantages of a short C.I. The economic valuation of these atypical milk production practices will be dependent on the changes in return on investment, changes in risk (variability of return) and changes in flexibility of the production process.

Key Words: Milk Production, Economics

PHYSIOLOGY SYMPOSIUM

Luteal Cell Interactions and Function

101 Microvascular cycle in the primate corpus luteum: role of VEGF and angiopoietins. R. L. Stouffer*^{1,2}, L. K. Christenson¹, T. A. Molskness¹, and T. M. Hazzard¹, ¹*Oregon Regional Primate Research Center, Beaverton,* ²*Oregon Health Sciences University, Portland.*

The development, function and regression of the primate corpus luteum during the luteal phase of the menstrual cycle is accompanied by, and presumably dependent upon, formation, maintenance and degeneration of the luteal microvasculature. Recent studies established that microvascular endothelial cells comprise >95% of proliferating cells in luteal tissue; steroidogenic cells were not proliferating. Endothelial cell proliferation varied during the luteal life span, with the percent dividing (Ki67-positive) cells highest during luteal development, declining by midluteal phase, and reaching low levels after luteolysis (40, 28, and <5%, respectively). The factors controlling microvascular events in the corpus luteum, including endothelial cell proliferation, are poorly understood. Studies were designed to determine if concepts arising from embryologic models apply to the corpus luteum during the menstrual cycle, i.e., that a balance between vascular endothelial growth factor (VEGF) and the angiopoietins (Ang-1 and its endogenous antagonist, Ang-2) influences the growth, maturation, and destruction of vessels.

The results support a novel role of the midcycle gonadotropin surge to stimulate VEGF (protein) and Ang-1 (mRNA) expression in luteinizing granulosa cells of the periovulatory follicle. Moreover, Ang-1 but not VEGF expression may be promoted, at least in part, by LH-induced progesterone production. Following luteal development, levels of VEGF mRNA and protein in luteal cells peak by midluteal phase and decline at luteal regression. In contrast, Ang-2 expression peaks abruptly in the regressing corpus luteum near the end of the cycle. Preliminary data indicate that macaque endothelial cells from the corpus luteum contain VEGF receptors (Flt-1 and KDR) and respond to VEGF in vitro with increased proliferation. Luteal cell-endothelial cell interaction, via the VEGF-/Ang-receptor pathways, may control the microvasculature, and hence development and function of the corpus luteum during the ovarian cycle.

Key Words: Corpus luteum, Vascular endothelial growth factor, Angiopoietin

102 Gap junction-mediated cellular interactions in the corpus luteum (CL). A. T. Grazul-Bilska*, L. P. Reynolds, and D. A. Redmer, *Department of Animal and Range Sciences, North Dakota State University, Fargo.*

The CL is an organ that exhibits extremely rapid growth, development and regression during the course of each estrous cycle. The CL consists of small and large steroidogenic cells as well as nonsteroidogenic cells including endothelial cells, pericytes, fibroblasts and immune cells. Cellular interactions among these diverse cell types may be coordinated by several mechanisms, including contact-independent (humoral) pathways and contact-dependent (gap junctional) pathways. Gap junctions and the proteins (connexins) composing them are present in luteal tissues of several species. Expression of connexins and the rate of gap junctional intercellular communication (GJIC) are affected by the stage of luteal development and regulators of CL function. Connexin (Cx)26 and Cx32 are present in the cytoplasm and on the cellular borders of cells within parenchymal lobules and connective tissue tracts of the CL; Cx43 is located mostly in the parenchymal areas on the cellular borders between steroidogenic and nonsteroidogenic cells. Expression of Cx43 protein is greatest in early and mid-cycle ovine and bovine CL, and in ewes tends to be greater in large than in small luteal cells. In vitro, LH stimulates GJIC of small-to-small and large-to-small cells. Prostaglandin F₂ α (PGF) does not affect basal GJIC but decreases stimulatory effects of LH on GJIC. A cAMP agonist increases but an antagonist decreases GJIC of luteal cells. A protein kinase C activator and a calcium ionophore inhibit GJIC of luteal cells. In vivo administration of LH increases but PGF decreases basal GJIC of small-to-small and large-to-small luteal cells and progesterone (P₄) secretion by luteal cells from mid-luteal phase of the estrous cycle. Moreover, transfection of bovine luteal cells with Cx43 antisense oligonucleotide decreases LH-induced GJIC and P₄ secretion. These data indicate that gap junctions are involved in regulating P₄ production in the CL. Thus, gap junction mediated-cellular interactions are likely important in coordinating a variety of luteal functions includ-

ing hormone production, signal transduction, tissue growth, regression and angiogenesis. Supported by NIH grant 1R29 HD30348, NSF grants MCB-9306241 and ERH9108770, and USDA grants 93-37208-9224, 93-37203-9271, 96-35203-3269 and 98-02168.

Key Words: Corpus luteum, Cellular interactions, Gap junctions

103 Molecular regulation of progesterone secretion in the ovine corpus luteum. G. D. Niswender*, *Colorado State University, Fort Collins, CO.*

Cholesterol provided by low density or high density lipoprotein is the precursor for biosynthesis of progesterone. Once inside the cell, cholesterol can be used for steroidogenesis or esterified by long-chain fatty acids and stored as cholesterol esters in lipid droplets. When needed for steroidogenesis, free cholesterol is transported to the mitochondrion with the involvement of cytoskeletal elements and sterol carrier proteins. Transport of cholesterol from the outer to the inner mitochondrial membrane is both the rate-limiting step in progesterone biosynthesis and the step most dramatically influenced by second messengers. Steroidogenic acute regulatory protein (StAR) and peripheral type benzodiazepine receptors (PBR) have been shown to be involved in this transport. Endosepine, the natural ligand for PBR, also appears to be involved in regulation of the rate of cholesterol transport to the inner mitochondrial membrane where the cytochrome P450 cholesterol side chain cleavage enzyme complex converts the cholesterol to pregnenolone. Pregnenolone is then converted to progesterone by the 3 β hydroxysteroid dehydrogenase/ Δ 5, Δ 4 isomerase in the smooth endoplasmic reticulum. Progesterone appears to diffuse through the cell membrane. The generally positive short-term and long-term effects of stimulation of protein kinase (PK) A second messenger pathway and the negative effects of the PKC pathway will be discussed.

Key Words: Progesterone, Reproduction, Mini-symposium

PRODUCTION AND MANAGEMENT SYMPOSIUM

Management of Dairy Herds for 40,000 pounds (18,182 kilograms) of Milk Per Year

104 Survey of management practices used for the highest producing DHI herds in the United States. D. W. Kellogg*¹, Z. B. Johnson¹, and J. A. Pennington², ¹*University of Arkansas, Fayetteville,* ²*Agricultural Extension Service, Little Rock, AR.*

The average amount of milk produced by dairy herds varies greatly in the United States. Milk production per cow is a widely used measure of efficiency of dairy herds and can have a major influence on the profitability of the farm. Some producers have achieved more than 14,000 kg of milk per cow annually while the national average was 8,230 kg in 1999. Many factors combine to impact average production of a herd. This study was initiated to identify management practices that characterize the highest producing dairy herds. The top DHI herds in the country, based on yearly rolling herd average for milk, were identified and addresses were provided by DHI processing centers. At least 10 herds in each region of the country were included. The herd managers were surveyed to obtain information on nutritional management, productive management, herd health management, facilities, implementation incentives, preferred information delivery systems, and future plans.

Key Words: Management practices, Milk production, Highest herds

Key Words: Management Practices, Milk Production, Highest Herds

105 Optimal genetic improvement for the high producing cow. B.G. Cassell*, *Virginia Tech, Blacksburg.*

Selection for higher yields will continue, but objectives will broaden to include lifetime performance, health, and fertility traits. Energy balance affects health and fertility. Increases in production will favor cows with high yields and minimal loss of fitness from negative energy balance. Measures of energy balance require estimates of intake and body condition score. Breeding goals of the future may include traits that emphasize intake and nutrient utilization rather than body tissue mobilization to meet demands of high production. Type data will continue to be used as indicator traits for extended productive life, reduced incidence of mammary infections, or ease of milk harvest. Relationships

between AI bulls and cows will continue to increase, producing increasingly unacceptable inbreeding in many matings. Relatively complete pedigrees are required to manage inbreeding through mate assignment. The industry will be challenged to find cost effective identification systems that work in large herds. Promising technical advances in marker-assisted selection, cloning, and sexing of semen remain insufficient for widespread application. Long-term impact of such technologies will depend on profitable application by private business. Income generated by AI bulls would need to be nearly identical for sexed or unsexed semen before semen sexing would find wide application. Many genetic evaluations will be based on multi-trait systems that simultaneously evaluate several observed and/or unobserved characteristics of dairy animals. More traits will be evaluated more quickly following data collection. Two historically important features of dairy breeding schemes will dominate future programs. Producers will continue to rely on parturition to refresh milk secretion. Genetically superior sires identified through progeny test programs will continue to play a major role in creating the genotypes of cows that make 40,000-pound milk records.

Key Words: Genetic improvement, Lifetime economic merit, Selection goals

106 Reproductive management of the 40,000 pound dairy herd. J.S. Stevenson, *Kansas State University, Manhattan.*

Challenges facing high milk-producing cows limit their reproductive efficiency. These include interrelationships among body condition, DM intake, transition from the dry period to lactation, onset of normal estrous cycles, detection of estrus, and embryonic survival. Attention is required to details associated with diet formulation, feed bunk management, cow comfort in free stalls, holding pen, and milking parlor during extremes of temperature and humidity, proper hoof care, milking management and mastitis prevention, control of ovulation and estrus, and early non-pregnancy diagnosis. Estrus will be detected by automation using pedometry, rump-mounted pressure-sensitive radiotelemetric devices, and in-line parlor milk progesterone tests. More highly fertile heifers will

be inseminated with sexed semen or sexed embryos as a source of more replacement heifers. Strategies to impregnate high-producing cows will require more ovulation control before first and subsequent services without detection of estrus. Because of high rates of embryonic death, more pregnancies will be achieved by inseminating sexed embryos. Clones produced from adult "super" cows will be transferred to recipient cows. Intensive management of transition cows will occur by monitoring key metabolic markers using hand-held devices. These devices will allow early detection of illnesses that will be followed by proven interventions to alleviate some of their residual effects. Body condition will be monitored more closely to reduce dry cow and transition problems and prevent prolonged anestrus by maximizing early postpartum DM intakes. Cow comfort will be monitored more closely to minimize standing time for milking, maximize standing time for estrus and feed intake, and maximize resting time for rumination and more efficient milk synthesis. Many of the reproductive technologies used today will be refined and incorporated into the management of cows on fewer dairy farms with more cows per farm. Despite trends for longer lactations associated with bST and lesser pregnancy rates, renewed lactations following parturition will continue to be essential for longevity of cows in the herd.

Key Words: Reproductive Management, Dairy Cows

107 Feeding management of the dairy herds for 40000-lb. milk/ year. O. Kroll*, *Hachklait & Israel Cattle Breeders Association.*

Feeding and managing high yielding cows is a complex multi-facade undertaking. Formulating a diet for high-yielding cows consists of many factors: energy levels, dry mater intake, protein quantity and quality, ratio between energy and protein, forage quality and particle length. Correct balance of the formulated diet is the primary tool in production of high milk yields. The cow's comfort is another important aspect of management, which includes: grouping criteria, bedding material, number of cows in each group, size of area assigned to each animal and the accessibility of food and water. These factors can effect yield a great deal. Animal health, mainly during the transition period and economical conditions are also very important factors effecting diet formulation, management decisions and therefore milk yield. Additionally, feeding strategy can be viewed as a major limiting factor in optimizing milk production of high yielding cows. TMR feeding system, in which cows are grouped according to yield potential, parity and body condition may serve as the best method in management of large herds. Whereas individual feeding system might be best fitting for implementation as feeding and management strategies in small herds. Minimal changes of diet in mid lactation are an important tool in achieving and maintaining high yields in both systems. Tools such as bST and protected nutrients (amino acids, fat, mineral and vitamins) can be used to increase production. Nevertheless maximum dry matter intake and inclusion of a large variety of ingredients in the diet are needed to maximize the beneficial effect of such products. In conclusion, achieving high yields require the implementation of the following managerial recommendations: 1. Maintain a uniform diet and avoid abrupt changes. 2. Include a large variety of ingredients in the diet at all times. 3. Maintain the correct energy/protein ratio to control body condition and weight. 4. Reach maximum dry matter intake. 5. Avoid metabolic disorders by a proper dry cow feeding management. 6. Make sure to raise your heifers to the adequate size and condition. 7. Do your best for the comfort of the cows.

Key Words: Diet formulation, cow comfort, feeding strategy

108 Feeding management of the 40,000 pound dairy herds. M.F. Hutjens*, *University of Illinois, Urbana.*

Feed costs represents 40 to 60 percent of total production costs. Feed delivery systems vary depending on herd size, forage system, housing, labor availability, and economic investment. The following aspects will be discussed as dairy managers, veterinarians, consultants, and feed company/cooperatives design feeding systems, meet nutrient needs, and economically produce milk on U.S. dairy farms while competing in a world market place.

- Optimizing forage levels and types on dairy farms (emphasis on economics)
- Monitoring dry matter intake (emphasis on feed efficiency)
- Delivering nutrients to the mammary gland (emphasis on bioavailability)
- Processing forages and grain (emphasis on nutrient availability)
- Predicting rumen fermentation (emphasis on rumen environment, energy production, and amino acid flow)
- Reducing fecal and urine losses (emphasis on environmental risk)
- Balancing of milk components (emphasis on federal milk marketing orders)
- Reducing metabolic disorders (emphasis on transition cow management)
- Manipulating body condition score (emphasis on weight changes and trends)
- Evaluating feed costs (emphasis on economic measurements)
- Monitoring cow behavior and feed sorting (emphasis on nutrient intake)
- Optimizing cow comfort and environment (emphasis on nutrient balance)
- Assessing the role feed additives (emphasis on economics and function)

Key Words: dairy, feed management, dry matter intake

109 New technologies and decision-making tools for high producing herds. L. Jones*¹, ¹*FARME Institute, Inc., Homer, NY.*

As herds reach higher production levels, attention to detail in managing these herds must increase exponentially. The main issue in achieving 60 liters or more per day average production is to reduce stress on all aspects of the cows livelihood and to maximize dry matter intake. Cows must be housed in clean comfortable conditions, fed rations that support ruminal and general health, monitored for early detection of problems, and provided interventions when problems arise. Like the poultry and swine industry, housing systems for high producing dairy cows will incorporate environmental control systems to monitor and control temperature and humidity. Similar monitoring and control systems will be used to ensure that milking equipment is functioning properly and that milk is harvested without trauma. During the milking process, biosensors will be used to assess the health status of cows. Potential biosensors include conductivity, milk temperature, somatic cell content, as well as specific hormone measurements. With the adoption of electronic identification of animals, automated measurements such as activity and body weight are possible. It is nearly impossible to manually evaluate all data that can be collected on a high producing herd. Computer systems that utilize management-by-exception techniques provide early detection of trends and problems. Real-time electronic systems will be able to divert the deviate cow immediately after milking for inspection and treatment. Another decision making tool is the use of sentinel animals to monitor a group. These animals can have ruminal cannulae or routine blood profile monitoring. In addition to monitoring, high-producing herds also require intervention protocols (e.g., programmed ovulation for reproduction) to prevent animals from being culled involuntarily. Other bio-manipulations (e.g., bST) can be used to better utilize nutrients.

Key Words: Production, Monitoring, Biosensors

**PRODUCTION AND MANAGEMENT SYMPOSIUM
Anabolic Implants and Beef Carcass Quality**

110 Optimizing carcass value and the use of anabolic implants in beef cattle. T. H. Montgomery* and P. F. Dew, *West Texas A&M University, Canyon.*

The historical use of implants in ruminants dates to 1947 with the first implanting of Hereford heifers with diethylstibesterol (DES). Since that time several different implants have been developed with varying degrees of commercial success. It is recognized that the use of anabolic implants in beef cattle offer the greatest return on investment outside of ensuring adequate nutrition. While this may be true with respect

to increased weight gain and improved feed efficiency, the influence of anabolic implants on carcass characteristics has not all been positive. Since the early use of DES, packers have been concerned about the influences of implants on carcass quality grade and meat tenderness. With the increased use of anabolic implants and the introduction of combination implants this concern has been renewed and amplified. Both the estrogenic, trenbolone acetate (TBA), and combination implants, used today have been shown to increase live performance, carcass weight, rib eye area, and closely trimmed boxed beef weights. In terms of quality grade the use of anabolic implants have resulted in varying decreases in

marbling scores, and in some cases slight increases in the skeletal maturity of the carcass, thus decreasing the proportion of carcasses grading choice. An increased proportion of dark cutters, along with an increase in Warner-Bratzler shear force values, have occasionally been reported in combination with the use of anabolic implants. It should be noted that these results are limited and need to be treated with caution due to the large number of extraneous factors that can affect the proportion of dark cutters at slaughter and decreased tenderness after chilling. This paper will discuss in some detail the influences that anabolic implants have had and are having upon carcass characteristics and where future research needs to be directed. It will also explore different implant management strategies available to optimize carcass value based upon published research results.

Key Words: Anabolic Implants, Beef Cattle, Carcass Characteristics

111 Market economics of changing beef growth promotant regimes. S.R. Koontz*, *Colorado State University, Fort Collins.*

Some beef industry members state that reducing growth promotant use will decrease pounds produced, improve demand, and improve prices. This paper summarizes economic benefits of using growth promotants, discusses market institution changes necessary to reduce growth implant use, and discusses market economic impacts.

There are substantial benefits to operations using growth promotants. Improved animal performance results in \$25 to \$80 per head returns. The overwhelming incentive in the current commodity system where cattle and beef are traded on a per pound basis in a coarse and imprecise grading system is to use growth promotants.

Alternative marketing systems must be present before producers have incentive to change. These systems must offer premiums for reduced implant use to offset lost performance. In addition to strategic alliances, an industry standard regarding growth promotants could be incorporated into the USDA grading system. Aggressively implanted cattle could be placed in lower quality grades. The drawback is accurate measurement of implant use. Instrument grading is necessary.

Reduced implant use decreases finished cattle weight and red meat yield. The initial market impact is increased cattle and beef prices. However, producers respond by increasing the herd size and prices return to initial levels. The impact of reducing implant use is a larger, as opposed to a more profitable, industry. Profits encourage expansion offsetting decreased weight and yield. One large unknown is the impact on consumer demand. Research shows consumers can detect palatability differences in meat grown under different implant regimes. Consumers may or may not pay enough to reduce implant use. Simulations show if reduced implant use improves beef quality and demand then price improvements could offset increased costs. Reducing implant use will further impact beef markets by increasing yield grade premiums and discounts and decreasing the Choice-Select price spread.

Substantial changes to the cattle and beef marketing system must occur before reduced implant use will be feasible but the largest changes will not be seen in cattle or beef price levels.

Key Words: Beef demand, Implants, Economics

112 Dose-titration of implants containing estradiol benzoate and trenbolone acetate in a long-acting formulation on weight gains by grazing steers and heifers. R. M. Cleale*¹, L. L. Smith², N. Fattohi¹, and A. N. Sinha¹, ¹*Fort Dodge Animal Health, Princeton, N.J.*, ²*L. L. Smith Research & Development, Lodi, WI.*

SYNOVEX Plus implant pellets were coated with a formulation intended to extend the release of estradiol benzoate (EB) and trenbolone acetate (TBA) up to 200 days. This experiment was conducted to titrate effects of varying doses on weight gain by steers and heifers pastured for at least 200 days. Animals were implanted with one of the following treatments on Day 0: (1) sham-implanted controls, (2) 2 pellets (7 mg EB/50 mg TBA), (3) 4 pellets (14 mg EB/100 mg TBA) or (4) 6 pellets (21 mg EB/150 mg TBA). A randomized complete block design with 280 mixed breed beef heifers (initial weight, 189±2 kg) and 280 mixed breed beef steers (initial weight, 195±2 kg) was used. Within sexes, animals were stratified by weight into 70 blocks of 4 animals, then randomly assigned to treatments within blocks. Heifers and steers were group-managed separately in a rotational grazing system that began in

mid-May and ended in early December. Pasture forages were composed of about 65-70% grasses and 30-35% legumes. No protein or energy concentrates were fed. From November 1 to the end of the study, pasture forage was supplemented with haylage made during the summer from pasture clippings. Two-day animal weights were obtained at the beginning (heifers, Day -2 and 0; steers, Days -3 and 0) and end (heifers, Day 201 and 202; steers, Day 202 and 203) of the study. Weight gain data from heifers and steers were analyzed separately with an ANOVA model that evaluated random effects of block and fixed effects of treatment. Least square means were obtained, and pair-wise comparisons were made by the 1-sided t-test at the 5% level. Over 202 days, ADG by heifers receiving 0, 2, 4 or 6 pellets was .63, .67, .67 and .70 kg/day, respectively. The ADG by each implant group was greater than sham-implanted heifers ($P < .05$), but were not different from each other. Over 203 days, ADG by steers receiving 0, 2, 4 or 6 pellets was .73, .80, .82 and .88 kg/day, respectively. The ADG by each implant group was greater than sham-implanted steers ($P < .05$), and ADG by steers implanted with 6 pellets was greater than steers implanted with 2 or 4 pellets ($P < .05$). Compared to sham-implanted controls, coated SYNOVEX Plus implants with 6 pellets increased ADG 11.7% among heifers and 21.7% among steers over a 200-day grazing period.

Key Words: Anabolic, Cattle, Growth

113 Carryover effects of implants and monensin on feedlot performance and carcass characteristics. B.A. Gardner*, F.N. Owens, J.T. Wagner, C.E. Walenciak, R.A. Ball, and D.R. Gill, *Oklahoma State University, Stillwater.*

Steer calves ($n = 182$; 32 pens; 309 kg) that previously had received no implant, 14 mg estradiol 17 β (E17 β), 140 mg trenbolone acetate (TBA), or 14 mg E17 β plus 140 mg TBA and that had been limit-fed a 50 percent concentrate diet (either with or without 33 ppm monensin) for 56 d were utilized to determine the carryover effects of implant type and monensin on feedlot performance and carcass traits. Following the limit-fed period, all steers were adapted to a common diet (NEM = 2.02, NEg = 1.37 Mcal/kg DM) and identical implants (120 mg TBA plus 24 mg estradiol) on d 28 of the finishing period. Much of the weight benefit gained from E17 β implants during the limit-fed phase was retained through the feedlot period; none of the additional gain from TBA implants was retained. Steers previously implanted with E17 β consumed more ($P = .07$) feed during the finishing period but were less ($P = .05$) efficient than steers that had not been implanted with E17 β previously. Although steers that had previously received TBA alone or in combination were heavier ($P < .01$) at the beginning of the finishing period, ADG and gain:feed of these steers was lower ($P = .07$) than for steers that had not received TBA previously. Steers that had previously received E17 β were heavier ($P = .04$) upon conclusion of the finishing period and yielded heavier ($P < .01$) carcass weights than those not implanted with E17 β previously, partially explaining their greater ($P = .04$) longissimus area. Steers that had received a previous E17 β implant tended to have more external ($P = .09$) and internal ($P < .01$) fat which resulted in less ($P = .09$) desirable yield grades for their carcasses as compared to those which had not received a previous E17 β implant. The use of E17 β -containing implants accelerated ($P < .05$) skeletal maturity indices demonstrating estrogen is responsible for the negative effects of implants on carcass maturity. Results indicate implant regimen administered prior to finishing can substantially impact feedlot performance and carcass characteristics of steers.

Key Words: Implants, Feedlot Performance, Carcass Characteristics

114 Effects of implanting gestating *Bos indicus* cows with trenbolone acetate on weight gains and reproductive performance. T.A. Thrift*¹, G.E. Carstens², D.A. Neuendorff¹, A.W. Lewis¹, W.J. Wilson¹, and R.D. Randel¹, ¹*Texas A&M University, Overton*, ²*Texas A&M University, College Station.*

Multiparous and Primiparous gestating Brahman ($n=91$, BW=481 kg, BCS=5.0) cows were utilized to study the effects of trenbolone acetate (TBA) on weight gain, calving difficulty, and reproduction. Cows were randomly assigned to receive one of three treatments at approximately 180-194 days of gestation. The treatments consisted of 0 (control), .8 (medium), and 1.2 (high) mg TBA/kg BW. Prior to calving, cow BW, BCS and a blood sample (P4) were obtained at two week intervals. Post

calving, cow BW, BCS and calf weight were obtained at two week intervals. Estrus was monitored twice daily with the aid of a fertile bull equipped with a chin ball marker. All cows were managed as a group with free choice access to hay and pasture. Precalving weight and body condition changes were similar ($P > .1$) for all three treatment groups. Precalving serum progesterone was suppressed ($P < .05$) in the high implant group ($6.69 \pm .81$ ng/ml) and tended ($P = .1$) to be suppressed in the medium implant group ($8.14 \pm .84$ ng/ml) as compared to controls ($10.1 \pm .82$ ng/ml). No differences ($P > .1$) were observed for birth weight, calving difficulty score, calf vigor, or placental retention in the three treatment groups. Postcalving, control cows tended ($P < .1$) to maintain more weight and body condition than implanted cows. Pregnancy rate was reduced ($P < .001$) in medium (62.5%) and high (48.1%) as compared to controls (92.3%). The interval from calving to pregnancy was longer ($P < .05$) for medium (92 d) and high (98 d) groups as compared to controls (67 d). In conclusion, implanting gestating Brahman cows with TBA was not successful in increasing weight gain pre or post calving and had detrimental affects on reproductive performance.

Key Words: Brahman, Trenbolone acetate, Reproduction

115 Effects of varying levels of anabolic implants in the initial growing phase on performance and carcass characteristics of Holstein steers. S. L. Fowler^{*1}, J. L. Beckett¹, R. Brandt², and J. Algeo³, ¹Cal Poly State University, ²Hoechst-Roussel Agri-Vet Co., ³Algeo Consulting.

One hundred seventy-six Holstein steers (144 kg) randomly assigned to one of five treatment groups (n = 36) were used to investigate the effects of different levels of estradiol benzoate (EB), estradiol (E₂), zeranol (Z), and trenbolone acetate (TBA) during the early and intermediate feeding phases on growth and carcass characteristics. Treatment descriptions are listed in the following table. Animals were weighed at 28-d intervals and weight gain, average daily gain (ADG), and feed efficiency were calculated. Steers were harvested after 291 d on feed; carcass measurements were collected. All implanted groups had heavier ($p < .05$) average final live weights and improved ADG ($p < .05$) than non-implanted controls, but implanted groups did not differ ($p > .05$). Average longissimus muscle area was greater ($p < .05$) for all implanted groups compared with the control group, but did not differ by implant ($p < .05$). However, final carcass yield grade was not affected ($p < .05$) by treatment. The percent of steers with USDA quality grade of Choice or better was significantly lower for treatment B (26.5%) compared with treatments A, D and E (52.8, 51.4 and 57.1%, respectively; $p < .05$). Treatment C (38.9%) was intermediate and was not different from other treatments. Based on these data, the use of a combination of EB and P₄ in the early feeding phase depresses quality grade in Holstein steers. This depression may be partially attenuated by administration of TBA and E₂ in the intermediate feeding phase.

Table 1. Treatment Protocols, doses in mg

Treatment	Day 0	Day 60	Day 120	Day 180
A	Z(36)	Z(36)	EB(20) + P ₄ (200)	TBA(120)+ E ₂ (24)
B	EB(10)+ P ₄ (100)	None	EB(20)+ P ₄ (200)	TBA(120)+ E ₂ (24)
C	EB(10)+ P ₄ (100)	None	TBA(80)+ E ₂ (16)	TBA(120)+ E ₂ (24)
D	TBA(40) + E ₂ (8)	None	TBA(80)+ E ₂ (16)	TBA(120)+ E ₂ (24)
E	No implant	No implant	No implant	No implant

Key Words: Trenbolone Acetate, Estradiol, Growth Rate

116 Depletion of trenbolone acetate and estradiol benzoate from a coated SYNOVEX Plus long-acting implant in cattle. L.A. Kraft*, E. Szewczyk, C.W. Stewart, M. Doherty, A.N. Sinha, and K.L. Simkins, Fort Dodge Animal Health, Princeton, NJ.

Commercial SYNOVEX Plus (SP) implants were coated (15% w/w) to extend the release of trenbolone acetate (TBA) and estradiol benzoate (EB) for about 200 days. Thirty Hereford steers (200-350 kg) were used

to evaluate the depletion of TBA and EB from the coated Long-Acting (LA) and SP implants in cattle for 200 days. Cattle were blocked by pretreatment body weight and randomly assigned to an explant day within each block. All animals received a coated LA implant in one ear and an uncoated SP implant in the other ear. All cattle were maintained together on pasture and supplemented daily with 1-2 kg of a 16% crude protein concentrate per animal. Body weights were determined on Day -1 and again at sacrifice. The average daily gains ranged from 0.81-1.22 kg/day. No implants were lost and implant site reactions were minimal on day 40. Implants were removed from groups of six steers each on Days 40,81,120,160 and 200 and analyzed for TBA and EB content. The mean TBA and EB quantities recovered in the LA explants were significantly ($P \leq .05$) greater than those in the SP explants at all observation times. Also, LA to SP depletion ratios for TBA and EB were significantly less than one at all explant days indicating that depletion from the LA implant was much slower than from the SP implant throughout the 200-day period. The depletion rates (i.e. slopes) of TBA and EB were estimated using simple regression analyses of the depleted amounts versus days for the LA and SP implants. The depletion rate of TBA from the LA implant was 0.949 mg/day which was significantly ($P \leq .05$) less than the depletion rate of 1.714 mg/day from the SP implant. EB depletion was also significantly slower (105.7 versus 168.9 μ g/day) from the LA implant than from the SP implant. Estimates of the time required to completely deplete the TBA and EB from both implants were determined from the depletion rates. The TBA (201.8 mg) would be completely depleted from the SP implant in approximately 118 days, but not from the LA implant until 213 days. The depletion of EB (28.8 mg) from the SP implant would take 171 days compared to 272 days for the coated LA implant. In summary, coating the commercial SYNOVEX plus implant reduced the depletion of TBA and EB resulting in an extended release implant that lasted approximately 200 days.

Key Words: Beef Cattle, Trenbolone Acetate, Estradiol Benzoate

117 Comparison of carcass merit using serial real-time ultrasound measurements of bulls reared under two management programs. J.F. Baker^{*1}, R.C. Vann¹, T.D. Pringle², and J.L. Varnadoe¹, ¹The University of Georgia, Tifton, ²The University of Georgia, Athens.

A 2 yr study evaluated the influence of post-weaning management programs on carcass merit using serial ultrasound and actual carcass merit. Angus (n=79) and Polled Hereford (n=26) bulls were assigned randomly within sire post-weaning to either a feedlot (FE; n=46) gain test or a winter annual forage (FO; n=59) gain test. Calves were weaned in September, managed together until winter grazing was available in November and slaughtered in May. In March the FO bulls were placed in the feedlot and provided feedlot diet. Monthly (n=6) measurements included: weight and ultrasound estimation of ribeye area, back fat thickness, and percentage intramuscular fat (IMF). Data were analyzed with SAS procedures: GLM, STEPWISE, RANK, and CORR. The SAS-GLM model used to evaluate yearling ultrasound carcass merit included: breed, sire (breed), treatment, yr, weight, age, and yr by treatment. Sire (breed), treatment, weight, yr and the two-factor interaction significantly affected yearling ultrasound ribeye estimates. Ribeye least squares means and standard errors were: 65.02 ± 1.55 , 64.31 ± 1.55 , 66.44 ± 1.81 , and 59.34 ± 1.61 cm² for FE yr 1, FO yr 1, FE yr 2, and FO yr 2, respectively. Year, treatment, weight, age and the interaction significantly affected ultrasound back fat estimates. The interaction was due to the FE bulls in yr 2 being significantly fatter than FO bulls while in yr 1 the two treatments were similar. Breed and yr were significant effects for yearling ultrasound estimates of IMF. Angus bulls had significantly higher IMF than the Hereford bulls, $3.22 \pm .11$ vs $2.45 \pm .17$, respectively. The correlation coefficients between the ultrasound estimates of ribeye area with actual carcass ribeye area were larger and more consistent for the FO group. While the coefficients for the two fat measurements with actual carcass estimates favored the FE treatment, the correlation coefficients for FO treatment were often not different than zero and occasionally negative. However, the coefficients for final ultrasound estimates with actual carcass values were similar for both treatments. Management of bulls has important implications to the estimation of carcass merit using ultrasound. Selection criteria need to consider the management system when adjusting values.

Key Words: ultrasound, bulls, carcass merit

PRODUCTION AND MANAGEMENT SYMPOSIUM

Lameness in Cattle, Sheep, and Swine

118 Lower leg and foot lameness related to the environment in commercial sheep and swine operations. G. Kennedy*¹, ¹Pipestone Veterinary Clinic, MN.

This presentation will be a clinician's viewpoint, based on field experience.

The infectious diseases of foot scald and foot rot have proven to be difficult to control in the sheep industry. Foot rot is the one sheep disease other than scrapie that is capable of putting someone out of the sheep business.

Environmental conditions, moisture and temperature are factors in allowing these two diseases to propagate. These diseases do not do well in cold or dry conditions.

Foot baths are used to control the disease. Zinc sulfate baths are more effective if wet environmental conditions exist. Formaldehyde baths at ten-day intervals are more effective against scald and preferred in eradication programs. Feet must be trimmed prior to the use of formaldehyde. Hoof trimming, vaccinations and antibiotic treatment help control the disease. Preventative measures are based on quarantines and isolation. Swine present different problems than sheep. The environment plays a larger role. Swine lameness is a result of their housing or structural unsoundness. Animals that are not bred to be structurally sound do not tolerate confinement well.

Feet and leg soundness affect gilt selection rates. Abrasions due to concrete surfaces affect hoof, fetlock and hock areas. Selection rates of gilts raised on partial slats or waffle slats are higher than those reared on conventional slats. Overcrowding reduces selection rates.

Foot and leg problems are more severe on green concrete. Improper ventilation resulting in increased moisture increases foot and leg problems. Incorrect sow conditioning increases problems.

Crate design and material type are factors. Some boar studs use individual pens for housing, particularly in Europe. In this country, crates are used, but valuable terminal boars that don't need to be as structurally sound or injured boars are moved to pens and often do well with additional room and attention.

Lower leg and foot lameness in sheep is generally infectious in nature and enhanced by environmental conditions. Environmental components generally cause swine lameness. Infectious agents may contribute as a secondary factor.

119 A novel force plate system that detects lameness of dairy cattle. P. Rajkondawar*¹, U. Tasch¹, A. Lefcourt², B. Erez³, and R. Dyer³, ¹UMBC, ²USDA, ³UMCP.

Lameness caused by hoof and leg (H&L) ailments is a costly problem for the dairy farmer and an important animal welfare issue. Cow lameness necessitates medical treatment, reduces milk production, results in decreased body condition, impairs reproduction performance, and impacts

animal well-being. This paper describes a novel system that measures ground reaction forces related to animal locomotion. The ability to detect lameness based on the system measured responses is examined.

The system has a walkthrough layout with an initial step-up that compels the animals to space apart. The system consists of two parallel, left and right floor plates that are each supported by four load cells. When a cow walks through the system, the load cell reactions are recorded as a function of time. These signals are used to calculate an equivalent reaction force and location. When a single limb is on the plate, the calculated values represent the movement and reaction forces of that limb. Additionally, the system provides measurements of body weight and walking speed.

The system has been used to evaluate the limb movements of sound and lame cows. Calculated measures of particular interest include: peak ground reaction force [PGRF] normalized with respect to the body weight, step size, and stance time. Values of these variables for a sound and a lame cow are listed below. Note that the normalized PGRF and stance time of the lame rear limb are reduced by 40% and 60% when compared to the values for the sound cow. Furthermore, the step size of the lame limb is increased by 26%.

If the system were to be installed in the return alley from a milking parlor, lame animals could be identified and body weight determined without impeding the flow of animals. The authors are currently conducting a research effort to identify a set of limb movement variables that are characteristic of the early onset of H&L ailments, before the animal can be de

		Right Front	Left Front	Right Rear	Left Rear
Sound	Normalized PGRF	0.55	0.54	0.39	0.41
Sound	Step Size (cm)	100.9	98.6	101.3	114.7
Sound	Stance Time (sec)	2.0	2.3	2.0	1.7
Lame (1)	Normalized PGRF	0.58	0.53	0.24	0.39
Lame (1)	Step Size (cm)	93.0	84.9	128.0	89.0
Lame (1)	Stance Time (sec)	1.1	1.2	0.8	1.0

(1) Right rear limb is lame

Key Words: Lameness, Ground reaction force, Dairy Cattle

RABBIT SPECIES SYMPOSIUM

Value-Added Rabbit Production

120 How to feed the rabbit gastrointestinal tract. N. Irlbeck*, Colorado State University, Fort Collins.

Rabbits are found in virtually every country in the world providing protein, fiber, animal research and companionship (third to dogs and cats). Because of an ability to utilize low grain and high roughage diets, they may provide a major protein source in the future. Classified as an herbivorous non-ruminant, rabbits have a simple, non-compartmentalized stomach, an enlarged cecum and colon inhabited by microbes (primarily *Bacteroides*) - they practice coprophagy. Coprophagy enhances strategies of high feed intake (65-80 g⁻¹BW) and fast feed transit time (19 hr) allowing rabbits to meet nutritional requirements. Understanding idiosyncrasies of the rabbit's gut will provide insight to elicit maximum production. Microbes digest cellulose (14% vs 44% of cattle) in the hindgut of the rabbit, but contribution of amino acids from microbial protein is minimal. Lysine and methionine may be limited in traditional diets and urea is not utilized. Acetate is the primary VFA produced by microbes, with more butyrate than propionate. Unlike ruminants, more VFA are produced on starch than forage diets, however VFA provide limited energy. Fiber is essential to maintain gut health, stimulate gut

motility and reduce fur chewing. High starch diets can be incompletely digested in the small intestine due to rapid transit times and result in enteritis. Low energy higher fiber grains like oats are preferred. Low fiber diets result in gut hypomotility and reduced cecotrope formation, with prolonged retention time in the hindgut. Low levels of protein increase cecotrope consumption and high levels decrease consumption - a protein sparing mechanism. Coprophagy increases protein digestibility (50% vs 75-80% for alfalfa). Feces are excreted according to a circadian rhythm, and data indicate that the internal cycle differs when shifting from ad libitum to restricted feeding - compromising growth. Finely ground feeds lead to enteritis, so a coarse grind is recommended. Rabbits have an unusual calcium metabolism, absorbing calcium without vitamin D facilitation - excess calcium being excreted in the urine (parathyroid hormone and calcitonin regulate serum Ca levels). Diets high in calcium (alfalfa based) may result in kidney damage for animals at maintenance. Correct management of the gastrointestinal tract of the rabbit will maximize production.

Key Words: Rabbit, Nutrition, Gastrointestinal Tract

ROCHE BEEF CATTLE NUTRITION SYMPOSIUM

Beef Cattle Behavior

121 Review of technologies and methodologies for assessing cattle behavior. J. M. Stookey*¹ and J. M. Watts¹, ¹*University of Saskatchewan.*

Live observations made by human observers have provided the backbone of our knowledge and understanding of basic cattle behavior. Despite rigorous sampling procedures and standardization of event criteria, visual assessment of behavior in real time can be prone to error, bias or inconsistency. However, technological developments, beginning with the time lapse video recorder, including radio frequency transmitters and the recent GPS systems are currently being employed in the field to collect and record behavioral data. Automatic data loggers have been developed to monitor lying, standing, walking and foraging behaviour in free-ranging and feedlot cattle. In our own laboratory we have used technology to replace subjective scoring of behavioral responses with precise and objective measurements. Sound spectroanalysis of cattle vocalizations, using software available on most personal computers, has been used to tap into the cows own commentary on painful procedures and psychological stressors. Signals from electronic strain gauges and load cells have been recorded to quantify a restrained beef animals attempt to escape a painful experience, as a means of comparing various castration and branding procedures. Improved behavioral measurements via technology have proven in some cases to be more reliable and sensitive measures of the animals response than performance measures and physiological parameters. The amount of movement a bovine makes while standing on an electronic scale has been quantified by recording the analogue signals from the load cells as a method of replacing a subjective temperament score. In general the technology and the methodology is available to move towards more refined, quantifiable and objective measurements.

Key Words: Cattle, Behavior, Methodology

122 Behavioral characteristics affecting performance of grazing cattle. W.E. Pinchak*¹, ¹*Texas Agricultural Experiment Station.*

The intent of this discussion is to provide a contemporary synopsis of the relationships between behavioral patterns and cattle performance from grazed ecosystems, within the context of a changing beef industry. Nowhere are the forces of change in our industry more prevalent than at the cow-calf producer and stocker operator level. Selection for desirable behavioral attributes may be as profitable as selection for a single gene trait. Foraging behavior is the animal's response to a complex of individual sensory and nutrient inputs, as modified by experience and cohort behavior in the herd. Animal performance, within genetic constraints, then is the result of an individual or herds behavioral ability to adapt to a grazing environment and management. Increased emphasis in the industry is placed on individual animal performance and value as the means to improve product consistency. These changes necessitate we evaluate the behavior of cattle populations to identify those individuals that exhibit behaviors that improve product consistency and farm gate profitability. These potential outcomes will be discussed in terms of scaling behavior performance relationships from the individual to herd levels and back again. Specifically, behavioral relationships to thermal environment, grazing management, supplementation, herd management practices and landscape attributes will be explored in relation to efficiency of production and product value.

Key Words: Behavioral Scaling, Supplementation, Efficiency of Production

123 Effects of health status, performance, and environmental change on feeding behavior of feedlot cattle. M. N. Streeter* and M. E. Branine, *Roche Animal Nutrition and Health, Parker, CO.*

Understanding feeding behavioral responses of feedlot cattle to health, management, and the environment continues to be a challenge for the

cattle feeding industry. Many of the behavioral paradigms that influence management decisions are based on anecdotal experiences. Primarily because obtaining behavioral data without introduction of an artificial feeding environment or the high labor demanded by short-term observations of individual animals has limited research progress in this area. A technology recently has been developed that simultaneously monitors all cattle at the feed bunk or water trough in either a commercial or research environment. This system has been used to evaluate the impact of health status, animal performance level, feeding practices, and to a limited extent environmental change on feeding duration and frequency. Research suggests the variation noted in feeding duration and frequency for morbid cattle in commercial feedlot pens tends to be greater than that previously observed in research studies conducted using behavior monitoring techniques that alter social interaction. The concept that feeding management practices train cattle consuming high starch diets to develop eating patterns desirable for optimal ruminal stability and consequently performance does not appear to be supported by this research. Cattle consuming energy dense rations typically spend less than 60 minutes per day consuming feed. Research has indicated individuals with the poorest ADG appear to spend more time consuming feed than pen mates with the greatest ADG; with no apparent difference in feeding frequency. Feed consumption patterns do not appear to be altered by time of feed delivery, when feed is provided ad libitum once daily. Behavior data may become a valuable tool to identify poor performing cattle, train pen riders, alter management decisions and identifying morbid cattle earlier in the disease process thus improving treatment success and reducing medication cost.

Key Words: Feeding behavior, Feedlot cattle, Electronic monitoring

124 Behavioral management to improve feedlot cattle performance and health. J. McGlone*¹, ¹*Texas Tech University, Lubbock.*

Behavioral management to improve feedlot cattle performance and health. McGlone, J. J., Texas Tech University, Lubbock, USA. Feedlot cattle express complex behaviors that in the least are fascinating but in many cases are economically important. Behaviors of economic importance include, but are not limited to: feeding, drinking, behaviors during handling, patterns of elimination, dust-generating behaviors and anomalous behaviors such as bullying behaviors. This talk will focus on one important behavior as an example of how behavioral management can improve feedlot economic competitiveness. Defining feeding behavior includes recording the number of feeding bouts (meals), total time spent feeding, and total mass consumed per day and per feeding bout. Feeding behaviors in feedlots include placement of the head in the feed bunk, taking in feed (involving the lips, and tongue), chewing and swallowing. Feeding is followed by rumination behaviors, which may represent a behavioral need unique for ruminants. Feeding occurs in bouts and the measurement of feeding behavior is fraught with issues of relevance (ex., single-space feeders) vs. collection of reliable data in a commercial setting where feed intake per meal is difficult to measure. Little is reported about the genetics of feeding behavior, although based on data among breeds and from other species, a genetic component to feeding behaviors and feed intake is highly likely. Social facilitation and diurnal environmental cycles play important roles in determining group cattle feeding patterns. Management of feeding behaviors includes (a) design of the bunk to limit feed waste, (b) designing bunk quantity and quality of space to encourage or limit social behaviors during feeding, (c) use of feed additives and/or growth promotants that may modulate feed intake, (d) changing time of feeding to affect cattle performance and dust generation, and (e) attempts to increase feed intake during times of stress (ex., arrival, heat stress, etc.). In conclusion, behavioral management and stockmanship can be applied to feeding behavior of feedlot cattle to improve cattle performance, efficiency and to minimize environmental dust. **Keywords:** Cattle, Behavior, Feeding.

Key Words: Cattle, Behavior, Feeding

RUMINANT NUTRITION SYMPOSIUM

Starch Utilization by Ruminants

125 Effects of grain variability and processing on starch utilization by lactating dairy cattle. J. L. Firkins*, M. L. Eastridge, N. R. St-Pierre, and S. M. Noffsger, *Ohio State University, Columbus.*

Starch digestion in dairy cows has been extensively reviewed (e.g., Mills et al., *J. Anim. Feed Sci.* 8:451), but processing, other than steam-flaking (Theurer et al., *J. Dairy Sci.* 82:1950) has received much less attention. NE_L concentrations of diets were increased by 8.5% for high-moisture vs dried corn (24.0 and 12.8% moisture; Wilkerson et al., *JDS* 80:2487). They estimated that grinding vs rolling numerically increased NE_L of high-moisture corn by 12.0% but had no effect on dry corn. However, Callison et al. [*JDS* 82(Suppl. 1):118] indicated that particle size of dry, ground corn had a large influence (54.2, 49.7, and 88.7% true ruminal and 91.3, 92.2, and 98.0% apparent total tract starch digestibility for corn with mean particle sizes of 4.75, 2.56, and 1.15 mm, respectively), increasing NE_L in the total diet from 1.63 to 1.74 Mcal/kg (18% increase for the corn, 36.6% of dietary DM). Similarly, estimated NE_L was increased by 18 to 33 and 13 to 20% by steam-flaking corn

and milo, respectively, coinciding with higher ruminal starch digestibilities (Theurer et al.). Corn genotype affects starch digestibility [Dado et al., *JDS* 82(Suppl. 2):197]. Barley substitution for corn linearly increased ruminal and total starch digestibilities but quadratically affected NDF digestibilities in the rumen and total tract (Overton et al., *JDS* 78:1981). To optimize NE_L intake, the amount of ruminally available starch needs to be optimized to avoid increasing negative associative effects, reducing DMI, or increasing the incidence of ruminal acidosis (Nocek et al., *JDS* 80:1005), highlighting the need to predict digestibilities of starch in the rumen and relate this to fiber digestibility and effective fiber needs. Therefore, various dietary and microbial factors affecting starch digestibility will be reviewed, and multiple regression analyses will be done for effects of DMI and other dietary factors, grain source, and grain processing on site of starch digestibility. Limitations in present knowledge will be assessed and recommendations made, especially with regard to transition management.

Key Words: Dairy Cattle, Grain Processing, Starch Digestion

SHEEP SPECIES SYMPOSIUM The Compelling Need for Value-Based Marketing

126 A packing plant perspective of value-based marketing of lamb. B. J. May*, *Angelo State University, San Angelo, TX.*

In 1995, Texas lost its only major lamb slaughtering plant. With the closing of this plant, approximately 275 sheep and goat producers decided to build a new, inverted slaughter facility. This new plant, known as Ranchers' Lamb of Texas, Inc. currently produces approximately 7500 lamb and 1000 ewe, ram, and goat carcasses a week. Ranchers' Lamb opened in October of 1997 and in April of 1999 started purchasing lambs based on carcass weight ranges and prices. In January of 2000, Ranchers Lamb began constructing a 2 million dollar fabrication plant addition that will be capable of producing case-ready product, that includes fresh, pre-cooked, and pre-seasoned lamb in modified atmosphere packaging. This fabrication addition will allow Ranchers' Lamb to implement a program that would pay lamb feeders premiums for prime and choice carcasses with yield grades 1 and 2 and to assess discounts for carcasses with quality grades less than choice and/or with yield grades 4 and 5. This new premium and discount program will finally bring to fruition the vision of sheep and goat producers of being able to participate in a value-based marketing system.

Key Words: Lamb, Marketing

127 Value-based lamb marketing systems in other countries. D. L. Thomas, *University of Wisconsin, Madison.*

Many developed countries have national systems for classifying lamb carcasses for merit and price discovery. These systems involve some measure of carcass fatness and may include carcass weight and conformation. New Zealand (NZ) and the U.K. rank 5th and 6th among countries in sheep numbers and 1st and 3rd among countries for sheep meat exports. In NZ, all lamb exported (90% of total production) is marketed under a classification system. Lamb carcasses are classified into 18 carcass weight-fat cover classes. Fat cover is based on GR measurement - total tissue depth over the 12th rib at a point 11 cm from the midline of the carcass. Carcasses with a GR greater than 12 mm are not allowed to be exported as intact carcasses and must be broken into cuts and trimmed of excess fat before export. For carcasses weighing 13.3 to 21.2 kg, those with $GR \leq 12$ mm are most valuable with discounts of 10 to 15% for $12 \text{ mm} < GR \leq 15$ mm and 25 to 30% for $GR > 15$ mm. The classification system was compulsory for all export abattoirs until the 1999/2000 season. Abattoirs can now institute their own systems, but most have stayed with the old system. Great Britain uses a 5x7 grid for classification of lamb carcasses according to conformation (E, U, R, O, P from best to poorest conformation) and fat class (1, 2, 3L, 3H, 4L, 4H, 5 from less to more fat). Classification is by visual appraisal and is performed by trained graders from the Meat and Livestock Commission. In 1997, 28% of the national lamb kill (4.4 million carcasses) was classified. Target classes are E, U, or R conformation and 1, 2, or 3L fat class. Since 1993, 50% of carcasses have been classified in the

target sectors. Carcasses of less than 18 kg that fail to make one of the target sectors are generally of poor conformation, whereas carcasses of 18 kg and over that fail are generally too fat. There are large regional differences for distribution of lamb carcasses in the grid. In 1997, the percentage of lamb carcasses in the target sectors was 58.5% in England, 48.9% in Scotland, and 31.1% in Wales. In England and Scotland, the main reason for failure to make one of the target sectors was overfatness, and in Wales it was for poor conformation.

Key Words: Lamb carcass value, Lamb grading, Lamb marketing

128 Genetic and nutritional effects on lamb flavor. S. K. Duckett*¹ and P. S. Kuber², ¹*University of Georgia, Athens,* ²*Washington State University, Pullman.*

Annual per capita consumption of lamb in the United States has declined throughout the last 40 years to a level of 0.32 kg on a retail weight basis. In a recent survey, consumers identified taste as one of the most important factors when purchasing meat products and ranked lamb last among other meats (beef, chicken, fish, pork, turkey, and veal) for taste and overall preference. Research has shown that meat flavor resides in the water-soluble fraction, but that species-specific flavors are located in the lipid fraction of meat. In lamb, branched chain fatty acids of eight to ten carbons are believed to strongly contribute to its characteristic flavor. Oxidation products from long chain unsaturated fatty acids also contribute to flavor intensity in lamb. Research has shown differences in flavor intensity due to breed or sire breed; however, the results have been inconsistent and depend on the type of sensory panel used to evaluate the product. Lamb from fine-wool breeds were reported to have a more intense flavor than coarse-wool breeds, whereas lamb from hair sheep was described as being more desirable for flavor intensity than coarse-wool breeds. Nutrition of the lambs before harvest also impacts lamb flavor. Research has shown that finishing lambs on pasture increases lamb flavor and off-flavors. Grain feeding alone or supplemented while on pasture typically produces lamb with more acceptable flavors than on pasture alone. However, the extent that flavor intensity is altered depends on the type of forage and grain consumed. Feeding protected lipid supplements to alter fatty acid composition can reduce mutton flavor, but can increase off-flavors due to oxidation. Genetics and nutrition impact lamb flavor; however, more research is needed to determine ways to manipulate these factors to alter lamb flavor and increase its consumption in the human diet.

Key Words: Lamb, Flavor, Fatty acid

129 Prediction of composition on the live animal and carcass. D.F. Waldron*, *Texas Agricultural Experiment Station, Texas A&M University System, College Station.*

A value-based marketing system that rewards producers of superior carcasses has the potential to quickly bring about dramatic changes in the US sheep industry. In order to capture the economic rewards in a value-based marketing system, producers must be able to identify animals with superior carcass composition. Accurate evaluations of composition are important in management and breeding decisions. An ideal method of evaluating composition would have minimum cost and maximum accuracy.

A lack of economic incentive to produce superior carcasses has been one reason why genetic improvement for carcass traits has been limited. Genetic improvement for carcass value should be based on a selection objective chosen with a long-term outlook. The selection criteria may change over time as measurement technology changes.

Carcass composition changes as a function of maturity and feeding regimen. Management practices should be tailored to the genetics of the animals to capture economic rewards of the market.

Lamb producers must be able to realize economic rewards from producing superior carcasses. They, in turn, must be willing to invest in breeding stock of superior genetic merit. Genetic improvement, based on genetic evaluations for improved carcass value, will require consistent, clear market signals that are translated from the processor to the producer to the breeder and an economical, accurate evaluation of composition in live animals.

Key Words: Lamb, Genetic, Carcass

130 Use of sire referencing schemes to select for improved carcass composition. G Simm*¹, R M Lewis¹, J E Collins², and G Nieuwhof³, ¹SAC, UK, ²Signet, UK, ³Meat and Live-stock Commission, UK.

Objective genetic improvement in specialised meat breeds of sheep in Britain is based largely on the performance recording and genetic eval-

uation service provided by Signet. This includes the use of ultrasonic scanning and a selection index to identify animals with high genetic merit for lean growth. Substantial responses to selection (about 2% per annum in the unscaled index) have been achieved in an experimental flock in which selection was based on this index. There is also good experimental evidence that sires selected on this index produce pure-bred and crossbred progeny with improved carcass lean:fat ratio, at a range of degrees of maturity, and in a range of feeding systems. Over 20 sire referencing schemes have been established in Britain during the last 12 years, mainly in specialised meat breeds. These schemes account for about half of the performance-recorded flocks in Britain. The larger schemes involve around 6,000-7,000 ewes in 60-80 flocks. These co-operative breeding schemes create genetic links between flocks and years through the shared use of elite rams (reference sires), often via artificial insemination. Multi-trait animal model BLUP is then used to provide across-flock genetic evaluations. These in turn allow increased selection intensities and increased response to selection. In the specialised meat breeds, the lean growth index mentioned above is a primary selection criterion. High responses to selection for lean growth (about 1.75% per annum in the larger schemes) and other measures of performance are being achieved. These schemes also provide an ideal structure for the cost-effective adoption of new technologies, such as advanced methods for *in vivo* estimation of carcass composition and molecular genetic markers. The formation and growth of these schemes has been stimulated by (i) the national availability of relevant performance-recording services/selection criteria, (ii) the improved success of laparoscopic artificial insemination with frozen semen, (iii) the wider availability of genetic evaluation software and powerful computers, and (iv) research, and interaction with breeders, on the optimal design and operation of schemes, including a measure of connectedness among flocks.

Key Words: Sire referencing schemes, Carcass composition, Sheep

ANIMAL BEHAVIOR AND WELL-BEING

131 Stress and immune responses in loose and cross-tied horses during transport. C. Stull*¹ and A. Rodiek², ¹University of California, Davis, ²California State University, Fresno.

Ten mature, healthy riding horses were used in a cross-over design to study stress and immunological responses to 24-hours of road transport in a commercial van during hot summer conditions. The study consisted of two trial periods of four days each, with a pre-transit day to collect baseline data, followed by the day of transport, and two days of recovery. In the first trial, six horses were individually cross-tied while two pairs of horses were loose in a single compartment. The treatments were reversed for the subjects in the second trial, but their placement in the trailer was similar. Similar floor area was available to both the cross-tied (2.2 sq. meters/horse) and loose horses (2.7 sq. meters/horse). The van traveled a total of 1800 km primarily on interstate highways, stopping only for blood collections and to offer horses water from buckets. All horses had access to hay while in transit. Venous blood samples were collected at 0800, 1100 and 2000 h each day. On the day of travel, an additional sample was collected at 0700 h prior to loading at 0800 h. Blood samples were analyzed for cortisol, alpha-glycoprotein, white blood cell counts (WBC), neutrophil to lymphocyte (N:L) ratio, glucose, and the dehydration measure of total protein. The effects of either loose or cross-tied treatments were evaluated using repeated measures ANOVA with treatment and time as factors. All blood parameters showed time effects ($P < .05$) over the four day study. Significant time x loose/cross-tied interactions were shown for cortisol ($P = .0003$), WBC ($P < .0001$), N:L ($P = .0008$), and glucose ($P < .0001$) but not for alpha-glycoprotein or total protein ($P > .05$). Comparison by Student's t-test of blood samples collected at 0700 and 0800 h on the day of transit showed significant loading effects (loose, $P = .003$; cross-tied, $P = .007$) only for cortisol. All parameters returned to pre-transit levels by the conclusion of the 48-hour recovery period. This data implies that cross-tying horses for long periods of road transport is more stressful and has greater impact on the

immune system during transport and recovery than horses transported loose with similar floor area.

Key Words: Horse, Transport, Stress

132 Welfare of surplus calves in the dairy industry. S.T. Millman*, *The Humane Society of the United States, Washington, DC.*

Neonatal calves present unique problems for those transporting and marketing them. Recently, the dairy industry has been criticized for failing to ensure adequate care for surplus calves. In this review of the scientific literature, attention is drawn to factors affecting the welfare of surplus calves in transit, and suggestions for improvement are presented. According to the USDA, approximately nine million dairy cows and heifers calved during 1999. Assuming that 50% of these calves were males, 4,500,000 bull calves were culled or marketed. Of the 1,042,000 calves that were slaughtered in federally inspected plants, 42.9% were bob veal and 52.4% were formula fed calves. If federally inspected plants are representative of the industry, there were at least 1,017,000 neonatal calves transported during 1999, either to a formula fed veal production unit or directly to slaughter facilities. Neonatal calves are particularly vulnerable during transportation and marketing. Calves have behavioral needs that differ from needs of older livestock. For example, calves spend 18 hours per day resting. Young calves also have specialized feeding requirements, and may fail to recognize milk and water, even when they have been provided. Furthermore, calves respond differently to methods used to handle other types of livestock. Since calves lack strong motivation to herd together and lack strong fear reactions, they cannot be driven away from handlers. Neonatal calves are also particularly sensitive to pathogens and environmental temperatures. In the United States, legislation protecting the welfare of surplus calves is limited. The dairy industry seems unable to address this issue, since the low value of surplus calves provides producers with little economic incentive for improvement. Countries in the EU have developed legislation in response to the welfare problems associated with transportation of

young calves, and Canada has developed recommended codes of practice. Possible mechanisms for improvement within the US dairy industry are discussed.

Key Words: Transportation, Calves, Welfare

133 Genetic parameters for behavioral traits related to the temperament in German Angus and Simmental cattle. H. Mathiak, M. Gauly*, K. Hoffmann, R. Beuing, M. Kraus, and G. Erhardt, *Department of Animal Breeding and Genetics, Justus-Liebig-University of Giessen, Germany.*

Behavioral traits related to the temperament were studied and the genetic variability of these parameters were estimated in German Angus (Aberdeen Angus x German dual purpose breeds) and Simmental cattle. Temperament was defined as the animal's behavioral response to handling by a person. Five progeny groups of both breeds (Simmental, $n = 123$; German Angus, $n = 109$) were tested two weeks after weaning (225-245 days of age). The weaner calves were tested with a combination of a non-restrained and a restrained test, where they were able to move in small test areas in the presence or absence of a handler. One animal was separated first from a group of 10 animals (separation pen: 100 qm) into a smaller area (restraint pen: 25 qm). Total separation time (TST), time spent running during handling (TSR) in the restraint pen, and time spent in a corner (TSC) directed by the handler were recorded. Analysis of variance was performed with a model including breed and sex as fixed effects and a regression on the age of the calf. The model for estimating heritabilities included the sire as a random effect and sex as a fixed effect. Least square means for TST were 29.6 s for German Angus and 39.4 s for Simmental ($P < 0.05$). TSR were 12.1 s and 18.6 s, respectively ($P < 0.05$). TSC were 27.2 s and 22.6 s, respectively ($P < 0.05$). Heritabilities estimated for these characteristics were 0.12 (± 0.20), 0.28 (± 0.28) and 0.09 (± 0.78) for German Angus and 0.27 (± 0.30), 0.07 (± 0.18) and 0.23 (± 0.28) for Simmental. Simmental cattle were more difficult to handle than German Angus regarding these parameters. The estimated heritabilities of the behavioral traits open a way of selection for temperament in German Angus and Simmental cattle assuming the high standard errors were caused in majority by the limited number of animals.

Key Words: Temperament, Heritability, Beef cattle

134 Nursing behavior of pigs related to litter growth. G. E. Bressner, S. W. Kim*, and R. A. Easter, *University of Illinois, Urbana.*

Twenty-eight primiparous sows and litters were used to study nursing behavior of pigs as it relates to litter growth. Sows were fed ad libitum during the 21 d lactation and litter size was set to 10 pigs by cross-fostering as needed within 48 h postpartum. Weights of sows and nursing pigs were recorded weekly. Sows were separated into two groups of fourteen sows. Each litter from the first group of fourteen sows (control) was weaned on d 21 of lactation. On d 13, teat order of litters from the second group of fourteen sows was determined and on d 14, the five heaviest pigs (avg 4.34 kg body weight) from each sow in the second group were weaned leaving five small pigs (avg 3.46 kg body weight). Teat order for the remaining five nursing pigs from each litter in this group was determined again on d 21 of lactation and the pigs were weaned. Pigs suckled anterior (first to third pairs) and middle (fourth and fifth pairs) mammary glands more frequently ($P < .05$) (79.8 and 75.0%, respectively) than posterior (sixth to eighth pairs) glands (42.3%). However, the distribution of mammary glands suckled either by heavy pigs or by light pigs was the same ($P > .05$). One week after partial weaning, the majority of the remaining five small pigs tended to continue to suckle the same mammary glands (58.9%) even though these pigs had access to other, presumably superior, glands that had been suckled by heavier pigs. The weight gain of the five light weight pigs from the partially weaned sows was greater ($P < .05$) than that of the five light weight pigs suckling sows in the control group. This study suggests that the preference for a specific mammary gland is relatively strong and the pig does not choose to relocate when given the opportunity. There was no significant relationship between birth weight of pigs and the location of the suckled mammary glands. Finally, it appears that output from a specific gland may increase when the blood supply of nutrients is increased.

Key Words: Pigs, Nursing Behavior, Mammary Gland

135 Bedding material preferences of dairy cattle. D.M. Falconer, D. Fraser, J.M. Matias, C.B. Tucker*, and D.M. Weary, *University of British Columbia Vancouver, Canada.*

Two experiments examined the bedding preferences of dairy cattle. In experiment 1, pregnant Holsteins ($n = 12$) were individually housed with access to 3 free stalls each bedded with a different substrate: deep-bedded sawdust, deep-bedded sand, and a geotextile mattress. After 1 week of access to all 3 materials, substrate preference was determined by stall use and lying times, recorded for 24 h with time-lapse video recording. Each animal was then restricted to either sand or mattress for 2, 5, or 10 days. Average lying time and number of transitions between standing and lying were significantly ($P < 0.05$) less when the heifers were restricted to sand or mattress. After the restriction phase, animals were again allowed access to all 3 bedding types and final preference was determined. Ten of 12 animals continued to choose sawdust. In experiment 2, 12 more animals were tested with sand, sawdust (both as described above), and geotextile mattresses covered with 2-3 cm of sawdust. Initial and final preference tests as described above showed that 8 of 12 cows preferred sawdust. In the middle stage of the experiment, all animals were restricted to each bedding material in turn for 2 days. Average lying time, time spent in the stall, and transitions to lying were significantly ($P = 0.02$) lower for the sand-bedded stalls, but there were no differences between the other two surfaces. These results indicate that (1) cows prefer deep-bedded sawdust, (2) that lying time, time spent in the stall, and number of lying transitions are affected when cows are provided with sand or bare mattresses, but not with mattresses covered with 2-3 cm of sawdust.

Key Words: Cow comfort, Well-being, Behavior

136 A synthetic maternal pheromone stimulates weanling pig feeding behavior and weight gain. D. L. Anderson*¹, D. Thiabaud², and J. J. McGlone¹, ¹*Texas Tech University, Lubbock*, ²*Ceva Sante Animale, Libourne, France.*

Onset of feeding behavior in the weaned pig is slow due to changes in environment and diet. The objective of this study was to determine the effects of a synthetic maternal pheromone on the behavior and performance of weanling pigs. Maternal secretions were studied and a product formulated that mimics maternal odors. A total of 108 pigs were weaned at an average of 18 days in conventional indoor farrowing and nursery buildings (mechanical heating and ventilation, woven wire flooring). Pigs were randomly assigned to one of three treatments, based on litter and gender. Treatments included a 30 mL application of vehicle control (CONT), pheromone applied to the feeder (FEED) or pheromone on the pigs' snout (SNOUT). Behavior was video taped in time lapse for 48 h after weaning and a scan sampling technique was used to summarize pig behavior. Pig weights and feed intake were recorded weekly for 4 weeks. Pigs were kept 3 per pen in single-sex pens and 12 blocks of three treatments were examined (36 experimental units) for performance data and 10 blocks were examined for behavior (30 experimental units). Linear contrasts were used to compare CONT with PHER (FEED+SNOUT) treatments. PHER pigs had increased ($P = .01$) % time feeding compared with CONT pigs (2.0 vs. 1.1% $\pm .27$), but PHER spent less ($P = .003$) time in contact with the waterer than CONT pigs (0.28 vs. 0.84% $\pm .13$). PHER pigs spent less ($P = .03$) % time engaged in agonistic behaviors than CONT pigs (.86 vs. 1.69 $\pm .30$). Over the entire 28-d growth period, PHER pigs had higher ADG (.244 vs. .198 $\pm .01$ kg/d; $P = .001$), heavier ending weight (11.8 vs. 10.6 $\pm .35$ kg; $P = .01$) and improved feed:gain ratio (2.08 vs. 2.65 $\pm .13$; $P = .002$) compared with CONT pigs. In conclusion, PHER stimulated postweaning feeding behaviors and reduced apparent drinking and agonistic behaviors while improving ADG and feed:gain ratio. Applying PHER to the feeder or snout of the pig were equally effective at modulating behavior and performance of weanling pigs.

Key Words: Pigs, Stress, Behavior

137 Effects of bedding on behavior and milk production of dairy buffalo. S. H. Raza*¹, S. M. Raza², and M. S. Khan¹, ¹University of Agriculture Faisalabad, Pakistan, ²Hi-Tech Feeds, Rawalpindi, Pakistan.

Twelve lactating Nili-Ravi buffaloes of almost same age, lactation stage, and weight were randomly allocated to 3 bedding; A (concrete floor), B (concrete floor + sand) and C (concrete floor + paddy straw) for a period of 26 weeks in a Completely Randomized Design, at University of Agriculture, Faisalabad, Pakistan. Feeding of roughage was free of choice and was offered 10% extra than previous day intakes. Concentrates were fed according to the milk production level of buffaloes. Sand and paddy straw were raked two to three times daily for aeration. Dry matter intake did not differ among all treatments. Milk yield was higher ($P < .05$) in treatments B ($6.40 \pm .22$ kg) and C ($6.07 \pm .26$ kg) than A. Milk fat percentage was $6.39 \pm .12$, $7.26 \pm .11$ and $6.60 \pm .17$ for A, B and C, respectively. The bedding showed a significant effect ($P < .05$) on milk fat percentage. Buffaloes in B treatment showed the highest ($P < .05$) fat percentage and produced 12% and 9% more milk fat than buffaloes in A and C, respectively. Buffaloes in C treatment spent 40% of their time sitting and 24% lying. While, buffaloes in A and B spent the minimum time lying. Sand bedding buffaloes spent less ($P < .05$) time (34%) standing than buffaloes in other treatments. Buffaloes in A and C treatments were found standing for more than 50% of the time. Sand bedding proved to be the more comfortable bedding material and animals preferred clean and cozy surroundings to exhibit their normal behavior. The paddy straw bedding showed a disadvantage of warping during nighttime and served as a harboring place for insects and mosquitoes and disturbed the normal behavior of the animals. The increase in milk yield in B could be due to the fact that buffaloes in this group spent most of their time lying.

Key Words: Water Buffalo, Bedding, Behavior

138 Correlation coefficients among productive, physiological and hormonal responses and temperature-humidity index in heat stressed Holstein cows. A. Correa*¹, D. V. Armstrong¹, D. E. Ray¹, R. M. Enns¹, C. M. Howison¹, H. G. González², F. J. Verdugo², and A. P. Márquez², ¹University of Arizona, ²Universidad Autónoma de Baja California, Mexico.

Data from an environmental modifications study conducted at the University of Arizona, Tucson, AZ, were used to estimate correlation coefficients among milk yield, milk fat, milk protein, rectal temperature (RT), respiration rate (RR) and triiodothyronine concentrations (T_3) with the daily maximum and minimum temperature-humidity index (THI). The correlation coefficients were calculated from records of 37 Holstein lactating cows during 120 d (May-September). The means and standard deviations were 80.6 ± 2.7 , 66.9 ± 5.4 , 36.4 ± 8.2 , 3.1 ± 0.5 , 2.9 ± 0.2 , 39.1 ± 0.6 , 66 ± 19 , 1.9 ± 0.7 for maximum THI, minimum THI, milk yield, milk fat, milk protein, RT, RR, and (T_3) in milk, respectively. The correlation between maximum THI and milk yield was similar to a previous report. RT had a very low correlation ($P > .10$) with the maximum THI, probably due to an effect of the environmental modifications (cooling systems). However, the minimum THI presented a moderate correlation with RT and RR supporting the importance of nights with low THI to reduce heat stress.

Correlation Coefficients

	Milk Yield (kg)	Milk Fat (%)	Milk Protein (%)	RT (°C)	RR (br min ⁻¹)	T_3 (ng ml ⁻¹)
Max THI	-.24*	-.04	.24*	.02	.25*	-.15*
Min THI	-.11**	-.03	.04	.18*	.19*	.03

* $P < .01$; ** $P < .05$.

Key Words: Heat stress, Dairy cows, Correlation

139 Effects of social stressors on belly-nosing behavior in early-weaned piglets. J.M. Gardner and T.M. Widowski*, University of Guelph, Ontario, Canada.

Belly-nosing is a behavior pattern commonly observed in early-weaned piglets. Although, belly-nosing has been referred to as an indicator of stress, the factors involved in its causation are unknown. The objectives of this study were: 1) to create varying degrees of stress by subjecting pigs to different combinations of social stressors; and 2) to determine

if there is an influence on the development of belly-nosing behavior in pigs weaned at 12-14 days. The experimental design was a 2x2 factorial with group composition (mixed litters vs. littermates) and density ($0.15 \text{ m}^2/\text{pig}$ (HD) vs. $0.4 \text{ m}^2/\text{pig}$ (LD)) as the main factors. Six replicates per treatment combination, of 6 pigs/replicate were conducted over three, 3-week trials ($n=144$). Aggressive behavior and belly-nosing were recorded every 5 min during one 4-h period on day 1 and during two 4-h periods on days 3, 7, 10, 14, 17 and 21 post-weaning. Blood was collected on days 3 pre-weaning and 3 and 10 post-weaning, from half of the pigs, for neutrophil:lymphocyte ratios (N:L) and plasma cortisol concentrations. Contrary to what was expected, aggression was greater for pigs housed at LD than those housed at HD, on days 10 ($P \leq .05$) and 17 ($P \leq .10$) post-weaning. These differences in aggression were reflected in both mean plasma cortisol concentration and variation in N:L. On day 3 post-weaning, variation in N:L was greater for pigs weaned with littermates ($P \leq .05$) and pigs housed at LD ($P \leq .05$). On day 10 post-weaning, both mean plasma cortisol ($P \leq .05$) and variation in N:L ($P \leq .05$) were higher for pigs housed at LD. Although plasma cortisol, N:L and aggression were all suggestive of a greater stress response in pigs housed at LD, there were no differences in belly-nosing for any treatment combination ($P \geq .10$). Belly-nosing did develop across all treatments by day 7 post-weaning, and the amount of belly-nosing was consistent with that observed in other studies (about 2% of the time) for pigs weaned at 14 days. Belly-nosing does not appear to be a general behavioral indicator of stress.

Key Words: Piglets, Social stress, Behavior

140 Influence of split marketing on the physiology, behavior and performance of finishing swine. L.V. Scroggs*¹, H.G. Kattesh¹, J.L. Morrow-Tesch², K.J. Stalder¹, J.W. Dailey², and J.F. Schneider¹, ¹The University of Tennessee, Knoxville, ²USDA-ARS, Lubbock, TX.

One hundred twenty high-lean, high-health barrows (20.3 kg BW) were randomly assigned in a randomized complete block design to one of three treatments: SM (split marketed), 6 pigs/pen ($1.1 \text{ m}^2/\text{pig}$); C (control), 6 pigs/pen ($1.1 \text{ m}^2/\text{pig}$); or MC (modified control), 3 pigs/pen ($2.2 \text{ m}^2/\text{pig}$). The heaviest (120.3 kg) one half of SM animals were removed one wk prior to penmates (116.3 kg) marketing. C (119.2 kg) and MC (121.8 kg) penmates remained grouped together until marketing. Animals were videotaped 72 h after placed on trial (t1), prior to (t2) and following (t3) removal of pigs in SM group. A blood sample was collected from each animal upon completion of t1, t2, and t3. After implementing a model including the fixed effect of treatment and the random effects of block and repetition using PROC MIXED of SAS, MC exhibited poorer ($P < .0001$) feed efficiency ($1.56 \pm .04$ kg) and ADFI ($2.88 \pm .06$ kg) compared to C ($1.06 \pm .04$, $1.96 \pm .06$ kg) or SM treatments ($1.07 \pm .04$, $2.00 \pm .06$ kg) over the entire study. The remaining penmates in the SM group had higher ADFI ($3.32 \pm .43$ kg; $P < .05$) when compared to C ($1.70 \pm .43$ kg) or MC treatments ($1.90 \pm .43$ kg) during the last week of the trial. Regardless of treatment, animals were more ($P < .0001$) active (feeding, walking/standing) at t1 than at t2 or t3. Neutrophil:lymphocyte ratio and plasma haptoglobin levels were greater ($P < .0001$) at t1 compared to t2 and t3 but did not differ between treatments. No treatment or time differences were detected in total plasma cortisol. These results indicate that hogs remaining after SM have greater ADFI when compared to the performance of hogs managed in the same way with respect to group size prior to and after marketing of SM animals. Significant differences in performance between the treatment groups cannot be attributed to any physiological or behavioral measures as reported here.

Key Words: Swine, Behavior, Production system

141 Effects of prenatal exposure of dairy cattle to a low magnetic field on open-field behavior and relationship to humans. J. Broucek*¹, M. Uhrincat¹, C. W. Arave², T. H. Friend³, S. Mihina¹, A. Sandor¹, A. Hanus¹, and S. Marencak¹, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Utah State University, Logan, ³Texas A&M University, College Station.

An experiment was conducted using 24 Holstein calves. The dams of trial calves were exposed to a low magnetic field (MF) at the flux density ranging from $42.1 \mu\text{T}$ (head) to $21.9 \mu\text{T}$ (hind part) during days 196-258 of gestation, while the dams of control calves were in an environment with a zero MF. An open-field test was applied at three ages:

A1 (16 weeks), A2 (25 weeks) and A3 (12 months) in an arena marked off into 9 squares. In A1 and A2, the size of arena was 4.5x4.5 m and two buckets with concentrate were placed there in. There was a red bucket in square 7 and a green one in square 9 (A1). At A2, the positions of the buckets were mutually changed. The calves were given four 5-min tests during two consecutive days. The animals were subjected to six, 10-min tests during 3 consecutive days at the A3 age in a 10x10 m arena. A gray manger was placed in square 8. The animals were exposed to isolation and silence in the first two tests, and to an unfamiliar person sitting on square 4 in the third and fourth tests. Noise (110dB, 1kHz) was used as a stress factor in the last two tests. The longest stay of both groups occurred in square 7 for ages A1 and A2. The stay was significantly ($P < 0.01$) higher in the trial group (145 s vs. 89 s) for the average of all tests. Calves in both groups preferred the red bucket with 70 % of sniffing by trial group and 60 % by control group animals. There were no differences between the times of first eating or the length of feeding. A lower frequency of staying at the manger and concentrate sniffing (9.5 vs. 12.2) and a shorter time of feeding (203 s vs. 313 s) were found in the trial group in all A3 tests. There were no differences between groups in frequencies or lengths of staying in square 4, but slightly higher values were recorded in a control group. Contact behavior, measured by the frequency (1.1 vs. 1.6) and length of sniffing of the person (16 s vs. 12 s) was not different. We conclude that magnetic field exposure to gestating cows has no impact on their calves as determined by open-field behavior and relationship to man.

Key Words: Dairy cattle, Magnetic field, Behavior

142 Effects of rearing methods of calves prior to weaning on subsequent open-field behavior at 28 weeks of age. J. Broucek*¹, M. Uhrincat¹, T. H. Friend², C. W. Arave³, S. Mihina¹, A. Hanus¹, S. Marencak¹, and P. Kiscak¹, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Texas A&M University, College Station, ³Utah State University, Logan.

Holstein heifer calves ($n = 92$) were assigned to one of five rearing treatments after having nursed their dams for 24 hours: A) a hutch until 7 days of age followed by group housing with a machine milk feeder until weaning at 8 weeks; D) penned with dam until 7 days of age followed by group housing with a machine milk feeder until weaning; H) a hutch until weaning; M) penned with dam for the first 7 days followed by a hutch until weaning; N) penned with dam for the first 7 days followed by penning with a nursing cow until weaning. Open-field testing commenced at 28 weeks of age in an indoor 4.5 x 4.5 m arena divided into 9 grids. Animals were subjected to four 5-minute tests on 2 consecutive days. A person unfamiliar to the calves was sitting at the midpoint of a wall facing the arena. In the first test, a red bucket was placed at one end of the arena and a green bucket at the opposite end (B1). In the second test (B2), the buckets were placed 1.2 m from the person. In test B3, the green bucket was placed within the reach of the left hand (0.5 m) of the person. A colored ball was also hung above the midpoint of the arena at the height of the calf's head (B3). In test B4, the buckets and ball were placed in the same place of the arena. The average number of the grid crossings in all tests was highest ($P < 0.01$) in D (19.6) and the lowest in N (12.1). The highest occurrence of animals sniffing the person was found in D and M (56 %), while animals from N displayed the lowest occurrence (29.4 %). The ranking of animals with regards to the total number of sniffing was as follows: M (46), D (35), H (21), A (16), N (5). Differences were significant ($P < 0.01$) between M, D and N. There were no differences in the number of encounters with the ball in test B3. In test B4, treatment M displayed the highest ($P < 0.05$) number of encounters (88 % animals) and treatment N (29.4 %) the lowest. In the evaluation of the entire test, heifers from groups D and M displayed the best relationship to man (sniffed the person the most) while heifers from group N displayed the worst. Play behaviour were most strongly expressed in groups M, D and A and the lowest in group N. Prewaning environment greatly alters open-field behavior and willingness to approach a man 20 weeks later.

Key Words: Calves, Rearing, Behavior

143 Comparing dairy cow behavior in new and old free stall facilities. R. J. Norell*, J. H. Packham, and W. F. Cook, University of Idaho, Idaho Falls, Montpelier, Emmett, ID.

The objective of this study was to compare cow behavior in old and new free stall facilities. Four dairy operations with old and new design free stalls were evaluated in Trials 1 and 2. Old stalls had limited lunge space to the side and front of the stall. New free stalls had large loop stall dividers, open stall fronts, and were mounted 1.02m above the curb in Trial 1 and 1.22m above the curb in Trial 2. In both trials, 50 Holstein cows were observed per housing facility for 8h (2x herds) or 5.5h (3x herds) after two consecutive evening milkings. Behavioral observations were made every 15 minutes. Data were analyzed as a completely randomized design within farm and aggregated within trial in a completely randomized split plot design. Mean %stall occupancy, %laying in stall, %eating, %loafing, and %cow comfort index for new and old stalls were: (Trial 1) 73.9, 73.1, 58.2, 55.6, 13.5, 12.1, 12.6, 13.2, 78.1, and 74.1 and (Trial 2) 78.3, 71.3, 68.7, 58.3, 13.2, 13.7, 8.5, 15.7, 87.7, and 81.4, respectively. New stalls in trial 1 did not enhance stall occupancy nor %resting time ($p > 0.10$) but slightly improved cow comfort index ($p < 0.05$). New stalls in trial 2 improved stall occupancy, %resting time, and cow comfort index ($p < 0.001$) and decreased %loafing time ($p < 0.001$). Cow behavior was improved in new free stalls with large loop stall dividers mounted 1.22m above the curb.

Key Words: Free Stalls, Cow Behavior

144 Study of neuroendocrine consequences of very early weaning in swine through the study of urinary excretion of corticosteroids and catecholamines. M. Hay*^{1,2}, P. Orgeur³, and P. Mormède¹, ¹Neurogenetics and Stress, INRA, Bordeaux, ²National Veterinary School, Toulouse, ³Animal Behavior lab., Nouzilly, France.

The investigation of physiological adaptive responses to husbandry practices is often difficult in pigs, especially in field conditions. This is due to a limited access to blood and also to the functional characteristics of neuroendocrine systems such as pulsatility and sensitivity to handling. Therefore, we recently developed a new approach through the measurement of corticosteroids and catecholamines in urine. We investigated the consequences of very early weaning of piglets. Sixty piglets from eight litters were either weaned on postnatal d 6 (early weaning, or EW piglets) or left with their dam until normal weaning at d 28 (control piglets, or C). On d 5, d 7, d 11, d 14 and d 19, urine was collected between 0700 and 0800 for the measurement of catecholamines, glucocorticoids, and creatinine. Compared with C, EW piglets displayed a transient increase in urinary cortisol on the day following separation from their dam (d 7) ($P < .05$). Urinary norepinephrine (NE) was three times lower in EW compared to C piglets from d 7 until d 14 ($P < .01$) but there was no difference between the two groups on d 19. Urinary epinephrine (EPI) did not differ between C and EW piglets on the day after weaning. Thereafter, EW piglets displayed a three times drop in urinary EPI as compared to C piglets until the end of the period ($P < .01$). Weaning induced an immediate reduction in growth rate and at d 28, the body weight of EW piglets was 1.60 kg lower than that of C piglets ($P < .0001$). The marked and prolonged suppression of the release of catecholamines likely reflects physiological adaptation to insufficient energy intake after weaning. The transient increase in cortisol excretion in weanlings may be caused by both emotional distress and acute food deprivation. This experiment shows the interest of this approach to monitor the physiological adaptive responses to husbandry practices.

Key Words: Stress Neuroendocrinology, Urine Analysis, Animal Welfare

145 Effect of transportation on young pigs. J. Morrow-Tesch*¹, J. McGlone², J. Dailey¹, and D. Anderson², ¹USDA-ARS, ²Texas Tech University, Lubbock.

Many early-weaned piglets are removed from the sow and transported to a separate location. There are currently no recommendations for the transport of segregated early weaned (SEW) pigs. Eight sows and their litters were used in this study. Three male and 3 female pigs (7 to 10 d of age) were selected from each litter and randomly assigned to treatments. Treatments were: control (C), pigs left in the farrowing crate with the sow ($N = 16$); isolated (I), pigs moved to a separate building and placed in a straw-bedded kennel for 8 hr without access to creep

feed and water (N = 16, 0.08m²/pig); and transport (T), pigs placed in a straw-bedded kennel and transported for 8 hr (N = 16, 0.08m²/pig). Behavior, temperature and humidity were continuously recorded in each of the three environments. Blood samples were collected by jugular venipuncture prior to moving the animals, and at 1, 4 and 8 hr and analyzed for hematocrit, total white and red blood cell counts, and whole blood glucose. Rectal temperatures and individual body weights were also collected. Data were analyzed using GLM within SAS. Transported pigs spent more time lying than C or I (50.6, 70.3 and 84.2% for C, I and T respectively) and time spent lying increased over time for C but decreased for I and T pigs (P < .001 for time by treatment interaction). Standing behavior increased over time for all three treatments (P < .05). Only C pigs showed nursing or agonistic behavior (P < .01). Pig weights were similar at the beginning of the study but C pigs gained 0.15 kg while I and T pigs lost .21 and .04 kg, respectively (P = .059, SE = .05 kg). Rectal temperatures were lowest for T pigs (39.16, 38.92 and 38.14 ± .10 ° C for C, I and T; P < .01). Glucose values were lowest for I pigs (129.6, 116.2 and 127.4 ± 2.36 mg/dl for C, I and T; P < .01). Transported pigs preferred to lie down during transport. Transport also caused a reduction in ability to maintain body temperature and weight without impacting glucose levels. Isolation of pigs at 7-10 d of age appears to play a large role in transport stress.

Key Words: Transport, Stress, Pig

146 Effect of transportation and commingling on the acute phase protein response of newly weaned calves. J. D. Arthington^{*1}, W. E. Kunkle², L. B. Davis², and S. D. Eicher³, ¹Range Cattle Research and Education Center, University of Florida, Ona, ²University of Florida, Gainesville, ³USDA-ARS, West Lafayette, IN.

Cattle producers, who have had positive experiences with retained ownership, often notice that their calves perform well if not commingled prior to or immediately after transport. The objective of this study was to investigate the effect of transportation and commingling on the acute phase protein (APP) response in newly weaned calves. Thirty-two calves were randomly allotted into one of four treatments (2 x 2 factorial design, transportation x commingling). Transported calves were loaded onto trailers within 3 h after weaning and shipped for 6 h. Commingled calves were penned with out-sourced, newly weaned calves of a similar age. Body weight, rectal temperature, and jugular blood were collected at weaning, immediately after shipment (d 0), and 1, 3, and 7 d after arrival. Feed and water intake within pen were recorded daily. Plasma fibrinogen and haptoglobin, and serum ceruloplasmin concentrations were determined. Neither transportation nor commingling affected water and feed intake over the 7 d study period. Transportation, but not commingling, affected body weight change by d 7 (-9.8 and 1.8 kg for transported and non-transported calves, respectively). Although not significant (P > .20), transported calves experienced a gradual increase in body temperature, dropping after d 3. This resulted in a greater (P < .01) decrease in body temperature (d 7 - d 0) in transported vs. non-transported calves (-1.55 vs. 0.84 °C). Transported calves had higher (P < .01) plasma fibrinogen concentrations compared to non-transported calves on d 0, 1, and 7. Similarly, serum ceruloplasmin concentrations were higher (P < .05) in transported vs. non-transported calves on d 7. Commingling did not influence fibrinogen or ceruloplasmin concentrations. Plasma haptoglobin concentrations were higher on d 7 in non-commingled calves compared to commingled calves, regardless of transportation. There was a significant transportation x time interaction, whereas transported calves had lower haptoglobin concentrations on d 3 compared to non-transported calves. These data suggest that the APP response is reactive to the stressors associated with calf weaning and transport.

Key Words: Transportation, Commingling, Calves

147 Effects of orientation on balancing ability during horse transportation. M. Toscano^{*} and T. Friend, Texas A&M University, College Station.

Several studies have attempted to determine the effects of orientation on a horse's ability to maintain balance during transportation. The results have often been contradictory because of differences in trailer design and lack of simultaneous comparisons. To determine the effect of orientation on a horse's ability to maintain balance while traveling in the forward or rear-facing direction, horses were transported over a

standardized course and each animal's total forward and backward motion during transport was determined. The course consisted of four laps around a 3.6-km rectangular course, each lap reversing direction, totaling 14.4 km. To mimic realistic travel, the course had artificial bumps, three turns (90°, 45°, and 135°), five straight-aways, and a hard stop at the end of each lap. Four separate stalls were mounted in a 16-m long commercial straight-deck trailer (16 wheels). Two forward-facing and two rear-facing horses were transported at the same time to allow for simultaneous comparisons. At the end of the first run, the orientation of each horse was reversed for the second run. A total of twelve horses were transported in each of the two orientations. The trials were recorded using a video camera positioned perpendicular to the length of the horse. During video analysis, a digital scrolling distance reader was placed on the television monitor over the shoulder or hip of the horse to record all forward and backward movement of that point for the entire course. Movement while forward-facing ranged from 4.75 m to 34.48 m, averaging 12.95 m; when rear-facing, movement ranged from 8.13 m to 35.21 m, averaging 16.99 m. Distance moved was not statistically influenced by orientation (P = .799) due to high variation between individual horses. Individual horses were relatively consistent in the distance they moved regardless of orientation. Thus, background and the individual characteristics of a horse may play a larger role than orientation in the ability to maintain balance during transport.

Key Words: Horse, Orientation, Transportation

148 Shade and water misting effects on behavior, physiology, performance and carcass traits of heat stressed feedlot cattle. F. M. Mitloehner^{*1}, J. L. Morrow-Tesch², S. C. Wilson¹, J. W. Dailey², M. L. Galyean¹, and J. J. McGlone¹, ¹Texas Tech University, Lubbock, ²USDA-ARS, Lubbock, TX.

Eighty crossbred feedlot heifers were used during Summer, 1999 to assess the impact of heat stress and its relief by shade and water misting on behavior, physiology, performance, and carcass traits. Treatments were: (1) no shading or misting (CONT); (2) only misting (MIST); (3) only shading (SHADE); and (4) shading and misting (SHMI). Head in feed bunk, head in or above waterer, walking, standing, and lying behaviors were observed using a 10-min scan sampling method and analyzed on a daily and hourly basis. Rectal temperature, respiration rate as well as performance and carcass measures were taken. Lying and walking behavior did not differ among treatments, but CONT cattle spent less time (P < 0.01) standing than SHADE and MIST cattle. Cattle in the MIST treatment performed less (P < 0.05) head-above-waterer behavior than CONT. Rectal temperatures did not differ among treatments, but respiratory rate was lower in shaded than in unshaded heifers (P < 0.05). Shaded compared with unshaded heifers had higher DM intake (9.46 vs. 8.80 ± 0.14 kg/d, P < 0.01) and ADG (1.6 vs. 1.4 ± 0.1 kg/d, P < 0.01). Heifers provided with shade reached their target weight 20 d earlier than the unshaded heifers and differed in final live weight (547 vs. 520 ± 6 kg, P < 0.01). Gain:feed, and calculated NEm and NEM concentrations were similar among treatments. Carcass traits were similar among treatments except actual and adjusted preliminary yield grade and hot carcass weight, which were greater for the SHADE heifers (P < 0.05). In conclusion, CONT cattle had a physiological and behavioral stress response to heat that negatively affected productivity. Providing shade decreased physiological responses to heat stress and reduced the negative effects of heat on performance, whereas misting was largely ineffective.

Key Words: Cattle, Heat Stress, Shade

149 Reducing pain after dehorning in dairy calves. P.M. Faulkner and D.M. Weary^{*}, University of British Columbia, Vancouver, Canada.

Behavioral responses after dehorning and a sham procedure were investigated in 20 Holstein calves aged 4-8 weeks. Calves either received a non-steroidal anti-inflammatory drug (ketoprofen) before dehorning as well as 2 and 7 h after the procedure, or were assigned to a control group. All calves received a sedative (xylazine) and local anaesthetic (lidocaine) before dehorning or sham dehorning, and responses were scored over 24 h after the procedure. After sham dehorning, behavior of the control and ketoprofen treated calves were similar and frequencies of pain related behaviors (head shaking, ear flicking and head rubbing) were near zero. After hot-iron dehorning, calves treated with ketoprofen also showed little head shaking or ear flicking but control animals showed much higher

frequencies of these behaviors, with both responses peaking 6 h after dehorning. Differences between the treatment groups remained statistically significant ($P < 0.05$) until 12 h (head shaking) and 24 h (ear flicking) after dehorning. A low frequency of head rubbing was observed in both treatment groups, but control calves were more frequently observed engaged in this behavior. There was no statistically significant effect of treatment on any of the other behavioral measures. Calves treated with ketoprofen also tended ($P = 0.07$) to gain more weight (1.2 ± 0.4 kg) during the 24 h after dehorning than did control calves (0.2 ± 0.4 kg). These results indicate that ketoprofen, an inexpensive and readily available drug, mitigates pain after hot-iron dehorning in young dairy calves.

Key Words: Well-being, Analgesia, Behavior

150 Effects of exogenous corticosterone during development on the physiology and behavior of chickens. D.C. Lay, Jr.*¹, M.F. Haussmann¹, and M.E. Wilson², ¹Iowa State University, Ames, ²West Virginia University, Morgantown.

The inability of researchers to control the maternal compounds that may affect the fetus has hindered the elucidation of mechanisms responsible for prenatal stress. Thus, we designed the following experiment to determine if the chicken could be developed as a model for prenatal stress due to its developmental autonomy. On d 16 of incubation, chicks (105 per treatment) were exposed to one of three treatments: 1) 60 ng of corticosterone (CORT), 2) elevated temperature (40.60°C) for 24 h (HEAT), or 3) no treatment (Control). At 7-d of age, 30 chicks per treatment were subjected to an isolation test. Latency to move, vocalization rate and incidence of defecation were recorded. At 14-d of age, a blood sample was obtained and chicks ($n=30$ per treatment) were weighed and beak-trimmed. Chicks were weighed and sacrificed at 21- and 70-d of age and adrenal glands were collected. Behavioral observations were conducted at 16-wk of age to record agonistic encounters and vocalizations. During the isolation test at 7-d of age, no differences were found for latency to move, vocalization rate, or defecation rate ($P > .20$). Adrenal weight and weight gain during the 7-d post-beak trimming were not different between treatments ($P > .20$); however, CORT chicks were heavier than the HEAT chicks ($P < .005$) but not Control chicks ($P > .20$) at 21-d of age. In addition, plasma corticosterone concentrations tended to be greater for CORT chicks as compared to Control or HEAT chicks ($P < .06$). At 10-wk of age, HEAT chicks had heavier adrenal glands than Control chicks ($P < .006$) but not CORT chicks ($P < .30$), and CORT chicks tended to have heavier adrenal glands than Control chicks ($P < .08$). At 16-wk of age, Control chicks performed more pecking aggression compared to either HEAT or CORT chicks ($P < .01$). Administration of exogenous corticosterone to chicks during incubation replicated some, but not all, of the effects seen in prenatal stress in mammals. Further development of this model may prove invaluable in furthering our knowledge of the mechanism for prenatal stress.

Key Words: Prenatal, Stress, Chicken

151 Monitoring adrenal activity and stress in dairy cows using fecal cortisol metabolites. C. J. Morrow*¹, E.S. Kolver², G.A. Verkerk², and L.R. Matthews¹, ¹AgResearch, Hamilton, New Zealand, ²Dairying Research Corporation Ltd., Hamilton, New Zealand.

The aim of the study was to stimulate adrenocortical activity in dairy cows and measure fecal cortisol metabolites comparing two immunoassays (i) 11-oxoetiocholanolone EIA and (ii) corticosterone RIA. The validity of measuring fecal cortisol metabolites was investigated by demonstrating that (i) injection of ACTH led to a significant increase in plasma and fecal cortisol metabolite concentrations in 5 nonlactating cows, and (ii) the translocation of 4 grazing cows to indoor stalls resulted in a 1.6 fold increase in fecal cortisol metabolite concentrations ($P < 0.01$). Plasma cortisol concentrations exhibited a 6-16 fold increase above basal concentrations 30 mins after ACTH₍₁₋₂₄₎ (0.05 mg i.v.; Synacthen) injection ($P < 0.001$) and remained elevated for 4.0-4.5 h. Basal fecal cortisol metabolite concentrations were 567.5 ± 101.8 ng/g and 11.2 ± 0.8 ng/g feces (mean \pm SEM, $P = 0.005$) for the 11-oxoetiocholanolone (measuring 11,17 dioxoandrostanes) and corticosterone assays, respectively. Fecal cortisol metabolites began to increase 8 h after ACTH injection and peaked between 14-18 h at 3565 ± 188.2 ng/g 11,17 dioxoandrostanes and 33.1 ± 3.2 ng/g corticosterone. Peak concentrations were more than 2.5 fold higher than basal ($P \leq 0.001$ for both assays). Fecal

cortisol metabolite concentrations remained elevated for 16 h (range, 11.9-18.5 h). The median digesta transit time between the bile duct and the rectum was 15.8 h (range, 9.6-44.1 h), as measured by transit of 3x5 cm nylon bags inserted via a duodenal fistula. Median transit time was aligned with peak fecal cortisol metabolite excretion. Despite the significantly higher absolute concentrations of cortisol metabolites detected by the 11-oxoetiocholanolone EIA, the response curves of both assays to ACTH injection were parallel and accurately reflected changes in plasma cortisol. Measuring cortisol metabolites excreted in the feces is a useful, alternative approach to evaluating stress in dairy cattle.

Key Words: Dairy cows, Fecal cortisol, Stress

152 Elevation of the percentage of cattle that vocalize is associated with handling and equipment problems in slaughter plants. T. Grandin*, Colorado State University, Fort Collins.

Aversive events such as prodding cattle with electric prods will increase the percentage of cattle that will vocalize during movement through chutes, stun boxes and restrainer conveyors. A total of 5,806 cattle were observed in 47 commercial slaughter plants with line speeds of 5 to 390/hr. Each animal was scored as either a vocalizer or a non-vocalizer while it was being moved through the system. In 20 plants (42 percent) 0 to 1 percent of the cattle vocalized, in 12 plants (26 percent) 2 to 3 percent vocalized, in 12 plants (26 percent) 4 to 10 percent vocalized and in 3 plants (6 percent) more than 10 percent vocalized. In two plants 12 percent and 17 percent of the cattle vocalized when they refused to move and they were prodded repeatedly with electric prods. Simple modifications of equipment significantly reduced vocalization percentages in 721 cattle observed in 5 plants (Chi square = $28.6 < .0001$). In the five plants, vocalization percentages were reduced from 7 to 2 percent, 8 to 0 percent, 9 to 0 percent, 17 to 2 percent and 23 to 0 percent, respectively. The following modifications were made. In the first plant electric prod voltage was reduced. In the second, third and fourth plants, balking by cattle at the entrance of a conveyor restrainer was reduced by illuminating the entrance or installing a false floor to eliminate the visual cliff effect. In the fifth plant, pressure exerted by a neck restraint device was reduced. In 70 percent (33) of the plants 3 percent or less of the cattle vocalized. All the cattle in these plants moved easily with a minimum of electric use. Scoring the percentage of cattle that vocalize could be used to identify handling problems which may compromise animal welfare.

Key Words: Cattle, Vocalization, Slaughter

153 The use of choice tests to evaluate dairy cow handling practices. E.A. Pajor*¹, J. Rushen², and A.M. de Passille², ¹Department of Animal Sciences, Purdue University, West Lafayette, IN, ²Agriculture and Agri-Food Canada, Lennoxville, Quebec.

Aversive handling of dairy cattle can result in reduced productivity, animal welfare and injuries to animals and handlers. Our objective was to study the aversiveness of dairy cattle handling practices by allowing animals to choose treatments in a y-maze. Animals were first trained to expect one treatment on one side of the maze and another treatment on the other side of the maze. Animals were then allowed to choose between the two sides. In the first experiment we validated the use of the y-maze, using 34 heifers who chose between a) pail feeding vs control b) hit/shout vs control and c) hit/shout vs pail feeding. Calves chose a) pail feeding significantly more often than hitting and shouting ($P < 0.001$), b) pail feeding more often than control ($P < 0.001$), and c) control more than hit/shout ($P < 0.001$). This demonstrates that animals can choose between treatments. In a second experiment, 3 groups of 8 animals were given choices between various handling treatments thought to be aversive a) shout vs hit, b) shout vs electric prod, and c) control versus tail twist. No significant difference was found in any of the three comparisons. In a third experiment 2 groups of 8 cows were used to determine if cows had a preference for hand feeding, or gentling over control. Cows showed no preference between control and gentling treatments but chose hand-feeding significantly ($P < 0.05$) more often than control. In a fourth experiment, 24 calves were used to determine if a preference existed for gentling, pail feeding, or hand feeding over control. In contrast to the adult cows, calves showed no preference between control and hand feeding. However, calves chose pail feeding more often than the control treatment ($P < 0.01$). Calves also showed no preference between control and gentling. In a final experiment, 24

cows were used to compare talking in a gentle voice, shouting and control. Cows showed no preference between talking in a gentle voice and control but chose control and talking in a gentle voice more often than shouting ($P < 0.05$). The results of these experiments demonstrate that the y-maze is an empirically valid method to compare handling treatments. Cattle show no obvious preference for physical gentling but are sensitive to the quality of the voice used when moving them.

Key Words: Dairy cattle, Behavior, Handling

154 Use of remote bunk monitoring to record effects of breed, feeding regimen and weather on feeding behavior and growth performance of cattle. K. S. SchwartzkopfGenswein¹, D. J. Gibb*², R. Silasi², S. Atwood², and T. A. McAllister², ¹Alberta Agriculture, Food and Rural Development, Lethbridge, AB, ²Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.

Thirty Charolais and 29 Holstein steers (432 ± 30 kg) were blocked by weight and breed and randomly assigned to four feedlot pens to study the effects of breed, feeding regimen and weather on feeding behavior and growth. The pens were equipped with radio frequency identification systems that monitored bunk attendance (time, frequency, and duration of visits) by individual animals. In four 21-d periods directly following adaptation to an 80% barley grain:20% barley silage diet, steers were fed to meet ad libitum intake (AL), restricted to 95% of DMI from the previous 21 d (RF), returned to AL, then restricted (RF) once again. Steers were weighed every 21 d for calculating growth parameters. Weather data (air temperature, AT; relative humidity, RH; barometric pressure, BP; and wind speed, WS) were recorded over the 84 d. Charolais steers made fewer visits to the bunk and spent less time there than Holsteins ($P < .0001$), but their ADG and feed efficiency (FE) were higher ($P < .0001$). Bunk visits were less frequent ($P < .0001$) and total daily attendance (TDA) was lower ($P < .0001$) with AL than with RF, irrespective of breed. Charolais and Holstein steers both had higher ($P < .0001$) ADG with AL than with RF, but this did not improve FE. Growth performance was better for Charolais than for Holstein steers on either feeding regimen. Highest TDA values were recorded for Charolais steers during AL ($P < .0001$), and lowest for Holsteins during RF ($P < .0001$). Weather effects varied with feeding regimen and breed. In terms of reduced TDA, Charolais steers were more sensitive than Holsteins ($P < .0001$) to changes in weather (AT, RH and BP), but this did

not compromise growth performance. Long term data collection will be required to relate the impact of weather on feeding patterns of feedlot cattle over different seasons and in different geographic locations.

Key Words: Cattle, Behavior, Radio Frequency Identification (RFID)

155 New technology for remote identification and 3D localization of livestock. I. Halachmi*^{1,2} and M. Braiman¹, ¹InfoRay Technologies, Israel, ²SAE Afikim, Israel.

A novel high frequency range Radio Frequency Identification (RFID) based on passive transponders has been developed and evaluated. Compared with the current state-of-the-art technology on the market the new technology has the following additional features: · The reading distance is more than 40m · The 3D co-ordinations (x,y,z) are available · Up to 1000 tags can be read simultaneously · The uniqueness of the tag is ensured by measuring the behavior of the coded signal. These options can be available to the market at no extra cost compared to the current RFID systems. The 3D coordination of an object is new technology that has potential for tracking and tracing animals. In cooperation with leading research institutions in Europe (IMAG-DLO, Wageningen, Holland) and Israel (Volcani center, A.R.O) an experiment was conducted. The aim of the study was (1) test and report to the public on the potential of the new technology; (2) develop a solution for the attachment of the electronic device to the animal; and (3) develop livestock health and welfare monitoring tools. The experimental farm is located in Kefar Yehoshua (Israel), and the experiment period was September 99 to July 2000. This research is part of a large-scale EU research proposal that has been submitted to EC, Brussels (Belgium). The technology can warn owners that animals have left their intended location as well as enabling efficient and mobile identification of animals from a distance. The potential has been studied for cattle, pig and sheep. The results suggest that the new technology has the potential for (1) monitoring beef cattle activity behavior on pasture; (2) estrus detection in beef cattle as well as dairy cows; (3) cheaper identification in large milking parlors; (4) early detection of health problems; (5) early lameness detection; (6) security and rapid theft detection; (7) contaminated cubicle (mastitis) detection; (8) monitoring and control over food intake; (9) alerting for "sucking cows"; and (10) animal inventory and control throughout the food chain.

Key Words: RFID, Cow, Identification

ANIMAL HEALTH

156 Effect of immunization with ferric citrate receptor FecA from *Escherichia coli* on experimentally induced coliform mastitis. K. Takemura*, J. S. Hogan, and K. L. Smith, Ohio Agricultural Research and Development Center, The Ohio State University, Wooster, OH.

The effect of immunization with FecA on intramammary infection and clinical mastitis following intramammary challenge of cows with *E. coli* 727 was investigated. Twenty-one cows were assigned to 7 blocks of 3 cows based on expected parturition. Cows within block were randomly assigned to one of 3 treatments: 1) FecA immunization, 2) J5 immunization, and 3) unimmunized controls. Immunizations were: 1) subcutaneous injection at 14 d prior to drying off, 2) intramammary infusion at 7 d after drying off, and 3) subcutaneous injection at 28 d after drying off. Challenge was by infusion of approximately 50 cfu of *E. coli* 727 into one uninfected mammary gland between 13 and 31 d after parturition. Cows within block were challenged on the same day. FecA immunized cows had greater immunoglobulin (Ig) G titers in serum and in mammary secretion against FecA antigen at calving, immediately prior to challenge, and 7 d after challenge than J5 immunized and control cows. FecA immunization also increased IgG titers against whole-cell *E. coli* 727 antigen in serum and in mammary secretion at calving compared with other treatments. Serum IgM titers against FecA antigen were greater in FecA immunized cows than in other groups immediately prior to challenge. FecA immunized cows tended to have lower bacterial colony-forming units, shorter duration of bacterial isolation in milk from challenged quarters, and lower rectal temperature compared with J5 immunized and control cows. Milk SCC from challenged quarters were greater in FecA immunized cows than in J5 immunized cows at 6 h after challenge. Milk SCC were greater in FecA and J5 immunized cows at 168 h after challenge compared to control

cows. Milk production and DMI did not differ among treatments. FecA immunized cows had reduced clinical severity in challenged quarters and shorter duration of clinical symptoms compared with J5 immunized and control cows. FecA was immunogenic in cows, and the antibody response was related to reduced clinical signs following experimental *E. coli* intramammary infections.

Key Words: Mastitis, Vaccine, FecA

157 Evaluation of the California mastitis test for screening dairy cows for intramammary infection at calving. J.M. Sargeant¹, K.E. Leslie*², J.E. Shirley¹, M.E. Sheffel¹, G.H. Lim², and B.J. Pulkrabek¹, ¹Kansas State University, Manhattan, ²University of Guelph, Ontario, Canada.

Monitoring of the prevalence of subclinical intramammary infection status at calving, and the specific pathogens involved, allows producers to evaluate the effectiveness of dry cow programs. However, culturing milk of all cows at the time of calving can be expensive and has not been widely adopted by the dairy industry. California mastitis test (CMT) has not been recommended for use in recently fresh cows. The objective of the present study was to examine the use of CMT for selecting quarters in fresh cows for milk bacteriological examination. Cut-points for defining a positive CMT test and length of time post-calving were evaluated. The study group consisted of 81 cows calving at the Kansas State University research dairy herd, and 50 cows calving at the University of Guelph dairy research herds. Quarter milk samples were collected for standard bacteriological culture on days 1 and 3 post-calving. A positive quarter was defined as one with a bacterial mastitis pathogen present at either day 1 or day 3 post-calving. CMTs were performed at cow side on

each quarter at the morning milking on days 1-10 post-calving. Quarters were scored as negative, 1, 2, or 3, as per manufacturer's recommendations. The sensitivities (specificities) of CMT for identifying positive (negative) quarters were calculated for different CMT cut-points and on different days post-calving. Intramammary infections were present in 36% of quarters. Quarters with intramammary infection had a higher mean CMT score throughout the first 10 days post-calving. The sensitivity of CMT for identifying positive quarters was highest when a positive CMT was defined as a score of 1 or greater. Using this criterion, a maximum sensitivity of 56.5% was found when CMT testing was performed on the third day post-calving (specificity = 56.1%). However, the sensitivity and specificity of CMT on day 3 post-calving for identifying major pathogens were 73.5% and 54.2%, respectively. The sensitivities of the CMT test on day 3 post-calving for identifying quarters infected with *E. coli*, *Klebsiella*, *Staph. aureus*, and environmental *Streptococci* were 50, 80, 60, and 84%, respectively. Thus, CMT used on the third day post-calving can be a useful aid for selecting quarters for milk bacteriological testing, and should be considered as one component of a fresh cow monitoring program.

Key Words: Mastitis, Post-calving, California Mastitis Test

158 Transgenic mice that secrete lysostaphin into milk are resistant to mastitis caused by *Staphylococcus aureus*. D.E. Kerr^{*1}, K. Plaut¹, A.J. Bramley¹, K.D. Wells², K. Moore², and R.J. Wall², ¹University of Vermont, Burlington, ²USDA-ARS, Beltsville, MD.

Our long-term goal is to generate transgenic dairy cattle with enhanced resistance to microbial infection of the mammary gland. This disease is common in the periparturient, lactating, and involuting mammary gland and costs the U.S. dairy industry approximately two billion dollars per year. *Staphylococcus aureus* accounts for about 30% of mastitis cases, and is often associated with chronic infection. Lysostaphin is a potent staphylytic enzyme normally produced by *S. simulans*. Recently, we modified the bacterial lysostaphin gene such that a bioactive gene product can be produced and secreted by eukaryotic cells. We have now generated transgenic mice containing this gene under control of the 4.2 Kb ovine β -lactoglobulin (BLG) 5'-regulatory region (BLG-Lys). Three lines of these mice have now been evaluated. One line, designated the high line, produces approximately 1 mg/ml of modified lysostaphin in milk; the medium and low lines produce approximately 150 μ g/ml and 75 μ g/ml, respectively. A murine model of experimental mastitis produced by intramammary infusion of *S. aureus* (10^4 cfu/gland) has been used to evaluate the bacterial resistance of the BLG-Lys mice. Eleven controls, and 11 BLG-Lys mice have been challenged (4 high-, 3-medium, 4 low-line; 2 glands/mouse). All mice were euthanized 24 hours post-infusion. Infection was established in all control glands. In contrast, glands of the high-line mice were completely resistant to infection, as were 43% of glands from the medium and low lines. The amount of lysostaphin in the glands (high, 100.6 ± 19.4 ; medium 12.0 ± 2.2 ; low 3.0 ± 0.4 μ g/gland) was related to the degree of infection. Further, 17 of 22 control glands were classified as severely infected ($>10^9$ cfu/gland), being accompanied by visible signs of infection such as viscous exudate surrounding the mammary glands. In marked contrast, the glands of transgenic mice never appeared to be infected. Thus, production of new antibacterial proteins by the mammary gland is a means to enhance mastitis resistance.

159 Tail docking dairy cattle. C.B. Tucker* and D.M. Weary, University of British Columbia Vancouver, Canada.

Tail docking dairy cattle is a management practice that is becoming increasingly popular among North American producers. The objective of our study was to assess two proposed benefits of tail docking: improved cow cleanliness and udder health. The study was carried out on a 500 cow commercial herd. The animals were housed together in a flushed, free-stall barn. Initially, half of the herd was docked, and all fresh animals joining the herd over the 60 day course of the study were also docked. Cow cleanliness was measured in two areas: the back, along the spine, and the side adjacent to the tail. Presence of debris in 5 X 17.5 cm grid with 14 squares was counted. Additionally, the quality of debris in the grid was scored on a scale of 0 (none) to 3 (thickly caked). Udder cleanliness was scored using the same scale (0-3) and by counting the number of teats with debris on them. Udder health was assessed by measuring SCC and the number of animals diagnosed as mastitic by the on-farm veterinarian. Cow cleanliness, as measured in the two locations,

did not differ between docked and undocked animals ($p > 0.31$). Udder cleanliness also did not differ between treatments ($p > 0.47$). In addition, SCC and incidence of mastitis did not differ between docked and undocked cows ($p > 0.66$, $p > 0.1$ respectively). Analysis of a sub sample of 19 cows illustrated individual differences in cleanliness ($p < .05$ for 3 of 4 measures of cleanliness). The results indicate that there are no cleanliness or health benefits associated with docking, but other management procedures, based on a better understanding of the individual differences, may be useful in improving cow cleanliness.

Key Words: Tail docking, Cleanliness, Mastitis

160 Oxytocin as a means of improving wound healing. M. N. Collins*, T. H. Friend, and I. Tizard, Texas A&M University, College Station.

Oxytocin is a hormone with many diverse functions and has recently been demonstrated to improve wound healing of musculocutaneous flaps in rats. Thirty-eight goats were used in this experiment to investigate whether oxytocin improves healing of wounds sustained from mechanical removal of the horns followed by cauterization. The goats were randomly assigned and received one of three treatments immediately following de-horning: 0.5 mL oxytocin (20 USP/mL) applied topically once a day on the wound site for five days ($n = 12$); 0.5 mL oxytocin (20 USP/mL) injected subcutaneously in the axillary region once a day for five days ($n = 13$); 0.5 mL chlorobutanol (preservative used in oxytocin) injected subcutaneously in the axillary area once a day for five days ($n = 13$). Circumference of the wound was traced on a clear acetate sheet immediately following dehorning and then once a day for five days. Wound area was measured by computer planimetry using a digitizer. Percent improvement (regression of the wound) was calculated as the remaining percent of the initial 100%. A significant difference was found between the subcutaneous oxytocin treatment (77%) and the control treatment that received chlorobutanol subcutaneously (104%), $P = 0.03$. The topically applied oxytocin treatment (82%) was not significantly different from the control treatment (104%), $P = 0.14$ or the subcutaneous oxytocin treatment (77%), $P = 0.66$. The mechanism by which oxytocin improves wound healing may be due to mechanical, systemic, or cellular changes.

Key Words: wound, oxytocin, goat

161 The effect of orally administered Seramune[®] as a colostrum supplement on growth, IgG levels, weaning age, morbidity, and mortality in Holstein heifer calves. A. L. Skidmore^{*1}, W. J. Prokop¹, D. A. Braun¹, D. Myers², C. Wright², and N. Wohlgemuth², ¹Attica Veterinary Associates, PC, Attica, New York, ²Sera, Inc., Shawnee Mission, KS.

The purpose of this study was to determine if small, economically viable doses of orally administered Bovine IgG would reduce morbidity when used as a colostrum supplement in newborn calves. Ninety-nine newborn Holstein heifer calves were treated at birth in a double-blind study. The treatment was 20 ml of concentrated bovine serum immunoglobulins, (IgG) or 20 ml of placebo (PLBO) mixed with first and second feeding of colostrum. The calves were housed at a conventional, well-managed commercial dairy and managed according to farm protocol. Colostrum quality was measured before feeding. Blood samples were taken before first and second feeding of colostrum, second day, 7-days post calving and at weaning. All calves were weighed at birth, day 2, day 7, weaning, and 1-day post weaning. All sick calf treatments and date of weaning or death were recorded. No significant differences were found between IgG and PLBO groups for the following parameters: colostrum quality (65.3 g/l and 70.7 g/l respectively); body weights at birth, day 2, day 7, weaning and 1-day post weaning; age at weaning; immunoglobulin levels for first colostrum feeding, day 2, day 7 and at weaning; and percent of calves that experienced illness (34.8% and 35.8% respectively). Due to a low incidence rate and small sample size mortality was not different between IgG and PLBO (2.2% and 5.7% respectively). A significant difference ($P=0.003$) between IgG and PLBO was noted in the number of sick calf days (26 d and 59 d respectively). In calves that received less than 100 total g of immunoglobulins at the first colostrum feeding, significantly ($P=0.01$) fewer sick calf days were noted between IgG and PLBO (2 d and 10 d respectively). In conclusion, small, economically

viable doses of Seramune® mixed with colostrum significantly decreased sick calf days.

Key Words: Colostrum, Calves, Health

162 Effect of rumenocentesis on health and productivity in dairy cows. H. Aceto*, A. J. Simeone, and J. D. Ferguson, *University of Pennsylvania School of Veterinary Medicine, Kennett Square.*

This study assessed effects of rumenocentesis on health and productivity. Subjects were 12 lactating Holstein cows matched by production (32.3-38.6 kg, 80-210 DIM) and randomly assigned to 4 groups of 3 cows each. At 7-d intervals over 21 d, cows received a sham (S; no abdominal penetration) or rumen (R) stick. Treatments were 3S; 1R/2S; 2R/1S; 3R. Group feed intake, milk production, rectal temperature and attitude were monitored daily. Left abdominal ultrasound (US) was performed twice weekly. Blood was collected weekly for measurement of haptoglobin, WBC and differential, and neutrophil oxidative function. A composite milk sample was analyzed weekly for fat, CP, MUN, and SNF by PA DHIA. On test day (TD) 1, group feed intake decreased by 23%. Milk production in S cows fell by 2.0 ± 0.9 kg (6.0%), whereas R caused a 5.1 ± 1.3 kg (15.3%) milk drop. Around TD 2, ambient temperatures were 35-38 °C with high humidity so R was superimposed on heat stress. Under these conditions, the fall in milk production seen in the herd (6.0 ± 0.4 kg, 17.9%) and in S cows (5.6 ± 0.6 kg, 15.7%) was similar, but in R cows milk drop was substantially higher (9.5 ± 1.8 kg, 28.1%). On TD 2, rectal temperatures in R cows (40.3 °C) were significantly elevated compared to S (39.5 °C). On other days, rectal temperatures in R and S cows were not markedly different. On TD 3, reduction in feed intake was less than on TD 1 and 2. Milk production did not decline after TD 3, but the post-heat stress rebound was slowed in R cows. US revealed abscesses in 7/12 cows. Deep abscesses formed after even one R. Superficial abscesses were seen only in 2 S cows. Rectal temperature, haptoglobin, WBC and neutrophil function were not helpful in identifying cows that developed abscesses. Milk composition was not different across groups. These findings suggest that rumenocentesis is not a benign procedure; it may lead to abscessation and causes a decrease in production (16%) that is compounded by heat stress (28%).

Key Words: Rumenocentesis, Milk production, Heat Stress

163 Johne's disease prevalence and transmission in an infected dairy herd. S.J. Wells*¹, R.H. Whitlock², and J.R. Stabel³, ¹*University of Minnesota, St. Paul, MN*, ²*University of Pennsylvania, Kennett Square*, ³*USDA-Agricultural Research Service, Ames, PA.*

In a longitudinal study to evaluate the epidemiology of Johne's disease (paratuberculosis), fecal samples from all adult cows within an infected herd were initially sampled, followed one year later by sampling of all cattle within the herd every 4 months for a total of 6 sample visits. Fecal samples were cultured for detection of *Mycobacterium paratuberculosis* using sensitive double incubation methods. Initial results showed 12% of adult cows were culture positive, followed by whole herd prevalences of 17%, 28%, 15%, 15%, and 13% at later visits; overall 32% of cattle tested at least one time were culture positive at least once. Over the period of sampling, the prevalence of fecal shedding by age group was 0% from 0-4 months of age, 4% from 5-8 months, 2% from 9-12 months, 5% from 13-16 months, 17% from 17-20 months, 12% from 21-24 months, 21% from 25-28 months, 25% from 29-32 months, and 24% from 33-36 months. From univariate analysis and within the population of cattle whose dams were also tested (127 animals), dam fecal shedding status was not related to cattle fecal shedding status. Cattle born during November through April were at higher risk of infection compared to those born during May through October, though this risk varied by year of birth.

Key Words: Johne's disease, Paratuberculosis, Epidemiology

164 The influence of injectable copper on immune response to bovine respiratory disease and occurrence of injection site blemishes. J.E. Rowntree*¹ and M.E. Boyd², ¹*Michigan State University, East Lansing*, ²*Mississippi State University, Mississippi State.*

Cattle entering the feedlot are often co-mingled and undergo radical dietary changes. These changes and a suppressed immune system often lead to feedlot morbidity and mortality. While copper (Cu) plays an important role in immunity, the Cu status of the incoming cattle are unknown. Therefore, our objective was to determine the effect of injectable Cu on immune response to Bovine Respiratory Disease (BRD), growth traits, carcass traits and injection site blemishes. One hundred ninety six newly weaned and yearling steers were randomly assigned to receive (1) 2-ml Cu Glycinate injection or (2) no injection. All yearling steers (n=76) were purchased from local sale barns and grazed on pasture until 12 to 15 mo of age before the study was initiated at the South Mississippi Experiment Station. The remaining cattle were from 7 to 12 mo of age and were located at the Leveck Animal Research Center (n=40), or three cooperator herds located throughout Mississippi (n=30, n=20, n=30). These cattle were preconditioned and treated similarly across location. Steers were vaccinated for BRD. Approximately 30-d following the initial vaccinations, steers were given a modified live booster for the BRD complex. Jugular blood was taken prior to vaccination and again at 50-d post vaccination which was prior to shipping to Hitch Feeders, Garden City, KS. Enzyme linked immunosorbent assays for Bovine Viral Diarrhea (BVD), Infectious Bovine Rhinotracheitis (IBR), Bovine Respiratory Syncytial Virus (BRSV), Adeno Virus, Para Influenza (PI₃) were performed on serum. Immune responses for BVD, IBR, BRSV, PI₃, Adeno Virus and *Mycoplasma Bovis* did not differ between treatments. Yearling steers had higher immune responses for IBR and BVD $P < .05$ than younger calves. There were no differences in feedlot morbidity and mortality or ADG. Cattle were marketed 148-d, 174-d, 189-d and 209-d after entering the feedlot. Carcass data was collected and blemish scores were given based on occurrence and severity. There were no differences for ribeye area, marbling score, backfat, or injection site blemish score.

Key Words: Copper, Feedlot, Carcass

165 The use of inactivated *Propionibacterium acnes* as an immunostimulant in off-site reared piglets compared to conventionally reared piglets. J.B. Morris*¹, D.H. Hellwig¹, and S.L. Krumpleman¹, *University of Arkansas, Fayetteville.*

168 weaned piglets (initial weight 5.8 Kg and 18 ± 3 d of age) were blocked by weight and assigned to one of two facilities. Facility one (n=96) was a typical commercial operation while facility two (n=76) was an off-site facility. Treatment was randomly assigned to pen within block. Commercially-available *Propionibacterium acnes* (Eqstim®) was injected IM (1mg/5.8 Kg). The control group received an IM saline injection. Piglets were bled prior to injection and then again at 1.5hr and 24hr to measure serum TNF- α and INF- γ response respectively. Average daily gain and average daily feed intake was calculated weekly. Health status was monitored throughout the trial, using pre-determined criteria, and a sub-sample of animals was sacrificed for evidence of sub-clinical disease. Piglets at the off-site facility were significantly heavier on day 7, 14, and 21 ($P = 0.04$, $P=0.08$, $P=0.03$) and average daily gain was significantly higher at the off-site facility on day 7 and day 21 ($P=0.04$, $P=0.002$). Average daily feed intake was significantly lower ($P= 0.08$) in the *P. acnes* treated group during the first 7 days. There were fewer animals treated for signs of respiratory or enteric problems at the off-site facility. The use of the *P. acnes* approached significance. Neither facility nor treatment showed any difference in sub-clinical disease.

Key Words: *Propionibacterium acnes*, off-site reared piglets

166 Infection of weaned pigs with *Actinobacillus pleuropneumoniae* fails to alter circulating interleukin 1 β , tumor necrosis factor α , and interferon γ . R. Balaji¹, K. J. Wright¹, J. L. Turner¹, C. M. Hill¹, S. S. Dritz¹, B. Fenwick¹, J. A. Carroll², M. E. Zannelli³, L. A. Beausang³, and J. E. Minton^{*1}, ¹Kansas State University, Manhattan, ²Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO, ³Endogen, Inc., Woburn, MA.

Infectious processes have been modeled experimentally with bacterial lipopolysaccharide (LPS). However, febrile, anorectic, and neuroendocrine responses to LPS are limited to a few hours post-challenge. In contrast, in porcine models of bacterial infection, these responses expand into several days post-infection, suggesting that LPS challenge models have limitations for modeling bona fide infectious processes. The current study was designed to assess changes in systemic cytokines in pigs in response to *Actinobacillus pleuropneumoniae* (APP) infection. Weaned pigs were housed in individual pens with free access to feed and water. Jugular catheters were inserted nonsurgically into all pigs about 7 d prior to challenge. At infection, pigs were given 5×10^8 CFU APP intranasally (n=3), or a similar intranasal volume of sterile media (n=3). Serum was collected at frequent intervals from -12 to 24 h relative to infection, and later assayed for interleukin 1 β (IL1), tumor necrosis factor α (TNF), and interferon γ (IFN) utilizing porcine specific ELISAs for each cytokine. Infection with APP failed to alter profiles of IL1 (P >.3), TNF (P >.5) and IFN (P >.5) in the 24 h post-infection. Concentrations of IL1 generally averaged between 30-70 pg/mL and TNF between 90-160 pg/mL for both treatments. All concentrations of IFN were below 20 pg/mL. We reported previously this APP model evoked a prolonged surge in serum cortisol, disrupted feed intake, and resulted in unmistakable clinical signs of disease in infected pigs. Thus, we conclude that this bacterial pneumonia model is not associated with changes in systemic IL1, TNF and IFN in weaned pigs.

Key Words: Pneumonia, Cytokines, Pigs

167 Insulin-like growth factor-1 (IGF-1) modulation of porcine lymphocyte function. C.T. Collier^{*1}, T.H. Welsh, Jr.², and J.C. Laurenz¹, ¹Texas A&M University, Kingsville, ²Texas A&M University, College Station.

The role of IGF-1 in the growth of animals is well established. Recently, there has been considerable interest in the potential immunomodulatory role of IGF-1. The present study investigated the effect of recombinant human IGF-1 and the synthetic glucocorticoid, dexamethasone (DEX), on concanavalin A (ConA)-induced lymphoproliferation and immunoglobulin (IgM) production by pig lymphocytes. Blood was obtained from male, crossbred pigs (n=3; 35 days of age) and lymphocytes obtained by density gradient centrifugation over Lymphoprep (Nycomed, Oslo, Norway). Lymphocytes were plated at 1×10^5 cells/ml in DME/F12 containing 10% fetal bovine serum, 2 mM L-glutamine, 10 μ M 2-mercaptoethanol, ConA (0 to 5 μ g/ml), DEX (0 to 10^{-5} M) and/or IGF-1 (0 to 100 ng/ml). Cultures were incubated for 96h and lymphoproliferation determined using the Celltiter proliferation assay (Promega, Madison, WI). In replicate cultures, supernatants were removed and IgM production determined using an ELISA specific for pig IgM. As expected, ConA induced a dose-dependent increase (P<.05) in lymphoproliferation and IgM production with (maximum effects at 1.25 μ g/ml). Although not affecting basal lymphoproliferation, DEX dose-dependently (P<.05) inhibited ConA-induced lymphoproliferation (maximal effects at 10^{-7} M). In contrast, DEX (10^{-7} M) inhibited (P<.05) IgM production by lymphocyte cultures at low ConA concentrations (0.6 μ g/ml), but was unable to suppress IgM production at higher concentrations of ConA (1.25 μ g/ml). IGF-1 induced a dose-dependent increase (P<.05) in both basal lymphoproliferation and in the presence of low concentrations of ConA (0.6 μ g/ml), but was unable to enhance lymphoproliferation at maximal concentrations of ConA (1.25 μ g/ml). Although unable to stimulate basal IgM production, IGF-1 induced a dose-dependent (P<.05) increase in IgM production in the presence of ConA. IGF-1 (50 ng/ml) also attenuated (P<.05) the suppressive effects of DEX (10^{-7} M) on both ConA-induced lymphoproliferation and IgM production. Collectively, these results demonstrate that IGF-1 can enhance lymphocyte function and reduce the suppressive effects of glucocorticoids, suggesting that IGF-1 may be beneficial to enhance immune function in pigs.

Key Words: Pig, Insulin-like growth factor-1, immunity

168 Levels of interleukin 6 mRNA in pigs infected with *Salmonella typhimurium*. R. Balaji, D. M. Grieger, K. J. Wright, S. S. Dritz, J. C. Nietfeld, and J. E. Minton^{*}, Kansas State University, Manhattan.

Treatment of pigs with bacterial lipopolysaccharide (LPS) results in changes in proinflammatory cytokine secretion and cytokine gene expression. However, we have shown that infection of pigs with both *S. typhimurium* and *Actinobacillus pleuropneumoniae* provoke clinical signs of disease and changes in the adrenal axis in the absence of changes in systemic proinflammatory cytokines. In the current study, we evaluated interleukin 6 (IL6) steady state mRNA levels in pigs infected with 3×10^9 CFU *S. typhimurium*. Pigs were penned in groups of 3 or 4 with ad libitum access to feed and water. After an acclimation period, pigs were given sterile broth orally or 3×10^9 cfu *S. typhimurium* in 5 ml broth. Pigs were sacrificed at 6, 12, 24, and 48 h following treatment. At sacrifice, samples of spleen, thymus, liver, hypothalamus, and anterior pituitary were obtained from each animal. Total RNA was extracted from each sample and subjected to slot blot analyses. Membranes were probed for IL6, then stripped, and probed again for 28s ribosomal RNA as a control for loading. Radiographic films were subjected to densitometric analysis, and abundance of IL6 mRNA was determined relative to 28s ribosomal RNA. Generally, tissues from 2 to 4 animals/treatment were represented at each sacrifice time. Although IL6 mRNA could be detected in all tissues, infection with *S. typhimurium* did not affect IL6 mRNA abundance through 48 h post-treatment. It had been previously reported that natural resistance-associated macrophage protein 1 (NRAMP1) mRNA was upregulated in samples of liver from these same animals, clearly indicating immune activation by this enteric disease challenge. Thus, we conclude that, unlike treatment with LPS, challenge with *S. typhimurium* is not associated with marked changes in IL6 mRNA.

Key Words: Disease, Interleukin 6, Pigs

169 Canavanine-induced life-sparing effect less apparent for mice fed 15.7% protein diets. D.L. Brown^{*}, Cornell University, Ithaca, NY.

Dietary administration of 1% canavanine had been shown to improve survival in female BALB/c mice consuming diets containing 23.4% protein (dry matter basis). In order to determine if this effect also obtains at more moderate dietary protein concentrations, 30 female BALB/c mice were fed a basal diet with 15.7% (dry matter basis) protein and another 30 were fed the same diet plus 1% canavanine. Neither mean (Control 873.2 d, Canavanine 870.0 d; SEM=34.2 d; P=0.949 from ANOVA) nor median (Control 902 d, Canavanine 884.5 d; P=0.9058 from Mann-Whitney) lifespans differed between groups. Although mean antinuclear antibody (ANA) titers did not differ between controls and canavanine treated mice at 833 days of age (19.84 vs 20.39 respectively; SEM=2.64; P=0.889 from ANOVA), one canavanine-treated mouse displayed an outlying ANA value denoting possible early sign of incipient autoimmune disease in that individual.

Key Words: Canavanine, Longevity, Protein

170 Chlorfenapyr residues in milk and tissues in dairy cows following application of ear tags containing chlorfenapyr. K.L. Simkins^{*1}, C.A. Hirschlein¹, and J.W. Higham², ¹Fort Dodge Animal Health, Princeton, NJ, ²American Cyanamid Company, Princeton, NJ.

The objective of this study was to determine if there were any residues of chlorfenapyr in milk and tissues from dairy cows following the application of two ear tags containing 30% chlorfenapyr. Seven Holstein cows producing 27.4 to 40.6 kg milk daily were randomly assigned to either a nontreated control group (3 cows) or a treated group (4 cows) which received one ear tag containing 30% chlorfenapyr, an insecticide for controlling horn flies, in each ear. Milk samples for analysis of chlorfenapyr were collected prior to treatment and at 1,2,3,6,8,10,13,15,17,20,22, 24,27 and 29 days posttreatment (PT). Milk fat samples for chlorfenapyr analysis were obtained at 15 and 29 d PT. All animals were sacrificed at d 30 PT for collection of muscle, liver, kidney and body fat for chlorfenapyr analysis. All milk samples from all cows having two chlorfenapyr ear tags had <10 ppb chlorfenapyr, which was the limit of quantification (LOQ) of the assay method. Low chlorfenapyr residues (12 and 18 ppb) were apparent in milk fat from two of the four treated cows at d 15 PT;

chlorfenapyr residues in milk fat from these two cows decreased to <10 ppb and 10 ppb, respectively, at d 29 PT. The body fat from the same two cows contained 11 and 20 ppb chlorfenapyr, respectively, at d 30 PT. For the other two treated cows and all control cows, milk fat and body fat contained <10 ppb chlorfenapyr. In muscle, liver and kidney samples from all treated and control cows, chlorfenapyr residues were below the LOQ for the methods (<10 ppb in muscle; <50 ppb in liver and kidney). These results show that chlorfenapyr residues following the application of two 30% chlorfenapyr ear tags on cows are below the LOQ for the methods in milk, muscle, liver and kidney.

Key Words: Chlorfenapyr, Milk Residues, Tissue Residues

171 Evaluation of a lateral flow test device for the determination of Immunoglobulin G (IgG) in colostrum. J. K. McVicker^{*1}, G. C. Rouse¹, D. M. Barrantes¹, and T. E. Besser², ¹Midland BioProducts Corporation, ²Washington State University, Pullman.

Although the assessment of colostrum quality can be determined by a variety of methods, those methods that specifically measure immunoglobulin G (IgG) are considered to be the most reliable. Radial immunodiffusion (RID) and turbidimetric immunoassay (TIA) are examples of methods that directly measure IgG, but these methods require long incubation periods or elaborate equipment, making them impractical as on-farm tests. Specific gravity measurement has been used as an on-farm test, but this method does not specifically measure any immune component. We have developed and evaluated a semi-quantitative, lateral flow test device capable of determining IgG concentration ranges in colostrum. The test device is specific for IgG, does not require refrigeration, and is not temperature dependent. In addition, the test is easy to use and results are produced in 20 minutes. The accuracy of the test device was evaluated with 100 colostrum samples representing a variety of dairy breeds. All of the colostrum samples were tested by three methods: (1) the lateral flow device, (2) turbidimetric immunoassay, (3) and by radial immunodiffusion. The ability of the test device to accurately determine the IgG concentration of the colostrum indicates that it would be a useful method to quickly determine the quality of colostrum.

Key Words: Colostrum, Immunoglobulin G

172 IS 900 PCR assay for detection of *Mycobacterium avium* subsp. *paratuberculosis* from bulk tank milk. S. Pillai^{*1}, B. Jayarao¹, D. Wolfgang¹, D. Griswold¹, L. Hutchinson¹, C. Burns¹, and R. Whitlock², ¹Pennsylvania State University, University Park, ²University of Pennsylvania, Kennett Square.

An Insertion Sequence 900 (IS 900) PCR assay was standardized by inoculating raw bulk tank milk and Middlebrook's 7H9 (M7H9) broth with each of 4 American Type Culture Collection strains (ATCC 19698, ATCC 43544, ATCC 43545, ATCC 43015) of *M. paratuberculosis*. Milk samples were centrifuged at 1950 x g for 30 min, and pellets obtained were divided equally. One half of the pellet was used for IS 900 PCR. The other half was decontaminated in hexadecylpyridinium chloride (HPC, 0.75%) and cultured (0.15 ml) on 2 slants each of Herrold's egg yolk medium (HEYM). Simultaneously, 2 more HEYM slants were inoculated with M7H9 suspensions (0.15 ml) of *M. paratuberculosis*. All recovery and detection experiments were replicated 6 times. Under experimental conditions, IS 900 PCR assay could detect *M. paratuberculosis* as low as 10 cfu/ml (3/6 replicates) - 100 cfu/ml (6/6 replicates). Further, IS 900 PCR detected *M. paratuberculosis* in 5/8 farm bulk tank milk samples from herds with known clinical history of Johne's disease. Two out of the 5 samples positive by IS 900 PCR were also positive by culture for *M. paratuberculosis*. The results of this experimental study will be validated by examination of bulk tank samples from several herds in Pennsylvania.

Key Words: IS 900 PCR, *M. paratuberculosis*, bulk tank

173 Inhibition of enterotoxigenic *Escherichia coli* adhesion to porcine small intestinal mucus receptor by *Enterococcus faecium*. L.Z. Jin^{*} and X. Zhao, McGill University, MacDonald Campus, Quebec, Canada.

The objective of this study was to investigate if a strain of *Enterococcus faecium* (EF) has the ability to inhibit the adhesion of enterotoxigenic

E. coli (ETEC) K88ac and K88MB to the small intestinal mucus receptor of piglets. The inhibition of adhesion of ETEC K88 to mucus receptor was assessed as the percentage of radioactivity in the test relative to the control by using a radioactive assay. The result showed that EF significantly inhibited the adhesion of *E. coli* K88ac to the small intestinal mucus receptors in a dose dependent manner. Inhibition > 93% was observed using 10⁹ CFU/ml or above of EF culture. The adhesion inhibiting effects of EF culture declined dramatically when the concentration of EF culture was 10⁷ CFU/ml or less. The bacterial cells, supernatant or the original culture of EF were tested separately to identify which part was involved in the inhibition. It was found that the original EF culture had the highest inhibitory effect (>93%) against the adhesion of *E. coli*, followed by the supernatant (79%) and bacterial cells (62%). Neutralized EF culture or supernatant (from pH 4.0 to 7.0) still showed the inhibitory adhesion of *E. coli* K88ac and K88MB to the mucus receptor, but in a lesser degree when compared to their counterparts (93% vs 74% for culture; 79% vs 60% for supernatant). It can be concluded that *Enterococcus faecium* culture, washed cells or its supernatant inhibited the attachment of *E. coli* K88ac and K88MB to porcine small intestinal receptor in vitro. The inhibitory effect was not solely a pH effect and might be attributed to sterical hindrance of binding sites.

Key Words: Escherichia coli, porcine intestinal mucus receptor, Enterococcus faecium

174 The immunological aspects of dystocia in cows and the newborn calves. R. Skrzypek^{*} and I. Szelag, Agricultural University, Poznan, Poland.

Eighty-three Black and White cows and their newborn sucking calves were investigated in this study. Blood samples were taken from cows 7-8 weeks before the expected parturition and 18 hours after parturition, while their calves were sampled 24 hours and 5 days after birth. Blood serum was assayed for total protein, globulins and gammaglobulins. In the dystocical cows (N=10) sampled before parturition, concentration of all serum constituents was significantly higher than in the healthy cows (N=73); total protein by 16.9 g/l (P ≤ .001), globulins by 10.1 g/l (P ≤ .05) and gammaglobulins by 6.5 g/l (P ≤ .05). Odds ratio (OR) estimates from the logistic regression analysis were also significant; OR=4.09 (P ≤ .01) for total protein, OR=2.64 (P ≤ .05) for globulins and OR=4.42 (P ≤ .05) for gammaglobulins. After parturition, no significant differences in blood composition between dystocical and healthy cows as well as no significant OR estimates were found. Dystocia had also significant effects on blood constituents of the newborn calves. At first sampling (24 hours after birth), in this group of calves compared with calves born to the healthy cows there was a lower concentration of total protein by 17.8 g/l (P ≤ .01), globulins by 13.5 g/l (P ≤ .01) and gammaglobulins by 7.2 g/l (P ≤ .05). Similar differences were found at the age of 5 days. It is concluded, that dystocia has a decreasing effect on passive immunity of the newborn calves and that the occurrence of this disorder can be predicted in cows by immunity tests performed 7 to 8 weeks before the term.

Key Words: Dairy cattle, Dystocia, Immunity

175 A comparison of techniques to measure rumen pH in lactating dairy cattle. T. Duffield¹, J. C. Plaizier^{*1}, R. Bagg², G. Vessie², P. Dick², and B. W. McBride¹, ¹University of Guelph, Ontario, Canada, ²Provel, Division of Eli Lilly Canada Inc., Guelph, Ontario, Canada.

Subacute rumen acidosis (SARA) is thought to be a common condition in early lactation dairy cattle, however, diagnosis is difficult. There are currently only two techniques available for measuring rumen pH under field conditions. Sixteen rumen fistulated cows were sampled in four sites of the rumen (cranial ventral, caudal ventral, central, and cranial dorsal) with a rumen cannula. These samples were compared to samples obtained at the same time with rumenocentesis (RC) and with an oral rumen probe (OP) (first 200 ml - OP 1, after 200 ml discard - OP 2). Rumen fluid was obtained between 6 and 12 weeks of lactation. Samples were analyzed for pH, lactate, bicarbonate, sodium, potassium, and chloride. OP samples had the highest pH values and the highest bicarbonate concentrations. RC samples had the lowest pH values and lowest bicarbonate concentrations. Small differences in electrolyte concentrations were noted between sites. The highest correlation of rumen pH was obtained

between RC and the cranial ventral rumen ($r=0.47$). When compared to samples obtained from the cranial ventral rumen, RC was highly sensitive (few false negatives), while OP samples were poorly sensitive. Both tests were moderately specific. The most accurate field test (highest combined sensitivity and specificity) was RC (81%). Improved field tests are required for better diagnosis of SARA on-farm.

Fluid Variable	OP 1	OP 2	RC	Cranial Ventral Rumen	Caudal Ventral Rumen	Central Rumen	Cranial Dorsal Rumen
PH	6.53 ^a	6.44 ^b	6.09 ^c	6.42 ^{abd}	6.31 ^d	6.10 ^c	6.30 ^d
Lactate*	1.20 ^a	1.19 ^a	0.51 ^b	0.66 ^c	0.37 ^d	0.63 ^{bc}	0.63 ^{bc}
Na*	100.5 ^a	97.1 ^{ab}	98.5 ^a	98.2 ^{ab}	93.4 ^b	91.7 ^b	96.6 ^b
K*	32.5 ^{ab}	32.8 ^{ab}	33.9 ^{ac}	33.6 ^{ac}	31.0 ^b	30.4 ^{ab}	30.6 ^a
Cl*	23.8 ^a	22.6 ^b	20.9 ^{bd}	21.6 ^b	18.8 ^c	19.2 ^{cd}	19.8 ^{cd}
HCO ₃ *	0.98 ^a	0.14 ^b	0.01 ^c	0.43 ^{ad}	0.03 ^{ce}	0.01 ^c	0.11 ^{bde}

Values having different letter superscripts within each row different at $P < 0.05$.

*mmol/L.

Key Words: rumen pH, subacute rumen acidosis, rumenocentesis

176 Blood Cholinesterase activity of beef cattle in humid tropical areas. V. Pardo^{*1}, K. Waliszewski², M. Garcia², N. Ibarra¹, M. Rodriguez¹, T. Betancourt¹, and J. Alfaro¹, ¹Universidad Veracruzana, Veracruz, Veracruz/Mexico, ²Instituto Tecnológico de Veracruz, Veracruz, Veracruz/Mexico.

The purpose of the study was to characterize normal whole blood, erythrocyte (RBC) and plasma Cholinesterase (ChEs) activity for healthy beef cattle produced in humid tropical areas exposed to organophosphate pesticides, since a public health hazard exists for ingestion of meat containing these chemicals. Twenty clinically normal male calves (*Bos Taurus x Bos indicus*) 6-8 months old were managed to control exposure to organophosphate compounds. Coumaphos (1 mg /kg bw) was sprayed to the experimental group (n=10) as a commercial formulation every 14 days during 6 months. Blood samples were collected from jugular vein from each animal prior to treatment and then once per month. ChE activity determination of whole blood, RBC and plasma was according to Ellman method. ChE and Acetylcholinesterase (AChE) activity was expressed as UI/mL. Sera Check (Bayer-6656) control serum was used. AChE was assayed with iso-OMPA. Results were analyzed by MANOVA with a L-Stat software validated with Minitab 10.5. General responses were statistically different ($p=0.007$) between the control and experimental groups and with the time ($p=0.005$). The mean ChE activity in the whole blood (4.23), RBC (28.00) and plasma (0.33) of the experimental group were significantly lower than the mean ChE activities of control group. The mean AChE activity in whole blood (1.74) and in plasma (0.11) of experimental animals were significantly lower than activities of control group. ChE activity in the RBC represented 83.1% of the whole blood ChE activity. Mean baseline ChE activity of 15.87 (whole blood), 77.31 (RBC) and 0.394 (plasma) was estimated for control group. ChE activity decreased 36.58% in RBC and plasma AChE was depressed 47.57%. Results indicate that administering Coumaphos at this dosis to cattle in tropical areas produces a significant inhibition in RBC ChE and plasma AChE activity when compared to baseline levels. RBC ChE inhibition could constitute an appropriate parameter for assessing exposure of cattle to ChE-inhibiting pesticides.

Key Words: Cholinesterases, Organophosphorus pesticides, Beef cattle

177 Blood Cholinesterase activity as an index of immunotoxicity of organophosphate pesticides in beef cattle. V. Pardo^{*1}, K. Waliszewski², M. Garcia², T. Sedas³, A. Moreno¹, P. Cervantes¹, T. Betancourt¹, and J. Alfaro¹, ¹Universidad Veracruzana, Veracruz Veracruz/Mexico, ²Instituto Tecnológico de Veracruz, Veracruz Veracruz/Mexico, ³Instituto Mexicano del Seguro Social, Veracruz Veracruz/Mexico.

The aim of this study was to determine the possibility to use blood ChE inhibition as a biomarker of adverse immunotoxic effect in cattle since the accumulation of the physiological effects of frequent exposure to non-acute doses is important. Twenty clinically normal male calves (*Bos Taurus x Bos indicus*) 6-8 months old were managed to control exposure to organophosphate compounds. Coumaphos (1 mg /kg bw) was sprayed to the experimental group (n=10) as a commercial formulation every 14

days during 6 months. Blood samples were collected from jugular vein from each animal prior to treatment and then once per month. ChE activity determination of whole blood, erythrocyte (RBC) and plasma was according to Ellman method. Sera Check (Bayer-6656) control serum was used. Acetylcholinesterase (AChE) was assayed with iso-OMPA. White blood cell (WBC) counting was assayed with a Cell-Dyn 3500 flow cytometer with veterinary package. Results were analyzed by MANOVA with a L-Stat software validated with Minitab 10.5. Correlation between ChEs activities and WBC variables (neutrophils, eosinophils, basophils, lymphocytes and monocytes) was performed by linear regression. General responses were statistically different ($p=0.007$) between the control and experimental groups and with the time ($p=0.005$). Blood, RBC and plasma mean ChE and activities of experimental group were significantly lower than the control group. Blood and plasma mean AChE activities of experimental group were significantly lower. Mean absolute number of eosinophils of experimental group was significant higher and was correlated to the decreased whole blood (0.99), RBC (0.58) and plasma (0.73) AChE activities. Mean absolute number of lymphocytes of experimental group was correlated to the decreased whole blood (0.99) and erythrocyte (0.58) AChE activities and plasma (0.62) ChE activity. Results suggest that the exposure to the pesticide could induce significant increase in the number of blood eosinophils and could induce changes in WBC.

Key Words: Cholinesterases, Organophosphorus pesticides, White Blood Cells

178 Effects of β -hydroxybutyrate, non esterified fatty acids, and urea on Sardinian sheep lymphocyte proliferation. N. Lacetera^{*}, U. Bernabucci^{*}, B. Ronchi^{*}, D. Scalia^{*}, O. Franci^{*}, and A. Nardone^{*}, Istituto di Zootecnia.

The study was undertaken to evaluate the effects of β -hydroxybutyrate (BHBA), non esterified fatty acids (NEFA), and urea (U), at physiological or supraphysiological concentrations (mimicking those occurring in normal ewes or in ewes affected by subclinical or clinical ketosis), on proliferation of sheep peripheral blood mononuclear cells (PBMC). Five non pregnant, non lactating, and non ketotic Sardinian ewes were utilized as blood donors. The PBMC were isolated by density gradient centrifugation, incubated with various concentrations of BHBA (0, 0.45, 0.9, 1.8, and 3.6 mmol/l), NEFA (0, 0.5, 1, and 2 mmol/l), and U (0, 5, 10, 15, and 20 mmol/l), and stimulated with concanavalin A (2.5 μ g/ml), or pokeweed mitogen (0.4 μ g/ml). The mixture of NEFA was represented by C16:0 (30%), C16:1 (5%), C18:0 (15%), C18:1 (45%), and C18:2 (5%). Cell proliferation was quantitated by an ELISA assay based on the measurements of 5-bromo-2'-deoxyuridine incorporation during DNA synthesis. Under the present culture conditions, the PBMC proliferation was not affected by the addition of physiological or supraphysiological concentrations of BHBA or U. Conversely, the addition of NEFA to cell cultures was responsible, at each of the three concentrations tested, for almost complete suppression of the proliferative response to concanavalin A ($P \leq 0.0001$), and pokeweed mitogen ($P \leq 0.001$). Suppression of the proliferative response to mitogens ($P \leq 0.0001$) was also observed in cells incubated with combinations of physiological or supraphysiological concentrations of BHBA, NEFA and U. Results of the present study indicate that the increases of plasma NEFA, rather than the increases of plasma BHBA or U, might contribute to explain the impairment of the immune response reported for sheep affected by subclinical or clinical ketosis.

Key Words: Sheep, Ketosis, Lymphocyte Proliferation

179 A trivalent vaccine for the treatment of chronic *Staphylococcus aureus* mastitis. P. Sears¹, A.J. Guidry^{*2}, A. Fattom³, S. Shepherd³, and C.N. O'Brien², ¹Michigan State University, East Lansing, ²Immunology and Disease Resistance Laboratory, ARS, USDA, Beltsville, MD, ³Nabi, Rockville, MD.

A trivalent vaccine for the treatment of chronic *Staphylococcus aureus* mastitis. P. Sears¹, A. J. Guidry², A. Fattom³, S. Shepherd³, and C.N. O'Brien², ¹Michigan State University, East Lansing, MI, USA, ²Immunology and Disease Resistance Laboratory, ARS, USDA, Beltsville, MD, USA, ³Nabi, Rockville, MD, USA. Previous studies reported that immunization of cows with an autogenous *Staphylococcus aureus* vaccine followed by antibiotic treatment cured 65% of quarters chronically infected with *S. aureus*. The current study was conducted in a similar manner using a trivalent vaccine (Nabi) that

contained *S. aureus* serotypes CP5, CP8, and 336, which account for 100% of *S. aureus* serotypes present in dairy herds in the United States and 96% of the serotypes present in European dairy herds. The vaccines contained either a killed autogenous *S. aureus* or the trivalent organisms in combination with aluminum hydroxide adjuvant, Selenium/Vit.E, and Vital E (Schering-Plough, Kenilworth, NJ). Cows diagnosed as having chronic *S. aureus* intramammary infections received three subcutaneous inoculations in the region of the supramammary lymph node at 0, 14 and 21 days after diagnosis of *S. aureus* intramammary infection. Cows also received six intramammary infusions of antibiotic at 1 to 2-day intervals beginning on day 14 after diagnosis of intramammary infection. Antibiotics alone cleared 1 of 23 infected quarters (4%) and 0 of 12 cows (0%). The autogenous vaccine + antibiotic cleared 25 of 42 quarters (60%) and 11 of 20 cows (55%). The trivalent vaccine + antibiotic cleared 16 of 21 quarters (76%) and 7 of 13 cows (60%). The data suggest that the "universal" trivalent vaccine is as effective as autogenous vaccines. This would allow for treatment of cows chronically infected with *S. aureus* without the necessity of preparing a herd-specific vaccine, thus preventing culling of valuable animals. Studies are under way using the trivalent vaccine for the prevention of *S. aureus* intramammary infections.

Key Words: Trivalent vaccine, *Staphylococcus aureus*, Mastitis

180 Effect of recombinant bovine soluble CD14 on CD18 expression of polymorphonuclear neutrophils in whole blood stimulated with lipopolysaccharide. Y. Wang*¹, D. Zarlenga², and M. J. Paape², ¹University of Maryland, College Park, ²IDRL, USDA/ARS, Beltsville.

Three million cases of clinical mastitis caused by Gram-negative bacteria occurs every year in the U.S. A significant number of these cases will result in acute endotoxin shock and death. The major responsible factor for acute endotoxin shock is the lipopolysaccharide (LPS) in the outer membrane of Gram-negative bacteria. LPS binds to polymorphonuclear neutrophils (PMN), monocytes and macrophages, and induces releases of cytokines. Soluble CD14 (sCD14) neutralizes LPS and limits the release of pro-inflammatory cytokines. In the present study, a C-terminal truncated recombinant bovine CD14 (rbsCD14) was cloned into a baculovirus expression system. The rbsCD14 contained a six-histidine tag at the C-terminal end. The rbsCD14 was not detectable on the cell surface of sf-9 cell infected with recombinant virus, but was present in the culture supernatant of infected sf-9 cells. The rbsCD14 reached the highest concentration in the culture supernatant around 72 h. Typical yields averaged 4 mg rbsCD14/L of supernatant. The LPS-free rbsCD14 were purified sequentially using nickel-conjugated affinity column and polymyxin-B-sulfate affinity column. The functional activity of rbsCD14 was measured by its effect on CD18 expression of PMN in whole blood stimulated with LPS. Incubating blood (n=2) with LPS (100 ng/ml) increased the CD18 expression of PMN by 12% (P < 0.02). This increase was inhibited by pre-incubation of LPS with 10 and 100 µg/ml rbsCD14 (P > 0.13), but not by pre-incubation of LPS with 10 and 100 µg/ml bovine serum albumin (P < 0.003). The changes in CD18 expression of PMN is a sensitive marker for activation of PMN by LPS. The results of this study indicated that rbsCD14 neutralized LPS and prevented activation of PMN. The rbsCD14 may have a role as potential adjuvants for the treatment of serious Gram-negative bacterial infections.

Key Words: recombinant bovine CD14, lipopolysaccharide, polymorphonuclear neutrophils

181 Hepatic metabolism of Ergot alkaloids in beef cattle by cytochrome P450. A. S. Moubarak* and C. F. Rosenkrans, Jr., University of Arkansas, Fayetteville.

Ergot alkaloids are considered to be a major factor in fescue toxicosis in farm animals, and the economical impacts have been well documented. Little is known about the metabolism and detoxification of ergot alkaloids in livestock. The objective of this study was to investigate the presence and involvement of cytochrome P450 3A (CYP3A) in the metabolism of ergot alkaloids in beef liver microsomes. We also describe a reverse-phase liquid chromatography procedure with fluorescence detection for determination of ergotamine metabolites. Liver microsomes were prepared from three steers (600 kg) grazing endophyte-infected tall fescue and also from male Sprague-Dawley rats (n = 4; 250 g) treated interperitoneally with dexamethasone (100 mg/kg in corn oil, for 4 d). Ergotamine metabolism was assayed in medium containing

liver microsome and NADPH at 37°C for 30 min. Rats treated with dexamethasone (inducer of CYP3A) showed 90% increased CYP3A activity over control rats. Ergotamine was hydroxylated first by CYP3A to metabolites M1 and M2 (8-dihydroxy-derivatives). The metabolites M1 and M2 were then converted to M3 and M4 (8,9-dihydroxy derivatives) by a second hydroxylation. Ergotamine isomer was hydroxylated in the same fashion as ergotamine to M1-Iso and M2-Iso. The formation of these metabolites was completely dependent on the presence of NADPH and was also microsome concentration dependent. Ergotamine was converted at a rate of 2 nM/µg microsome/min when incubated with bovine liver microsomes to produce a metabolite profile (M1, M2, M1-Iso and M2-Iso) similar (2.2 nM/µg/min) to the metabolites produced when ergotamine was incubated with liver microsomes of dexamethasone treated rats. This study shows that liver microsomes from beef animals grazing endophyte-infected tall fescue contain an enzyme capable of metabolizing ergotamine to a relatively more hydrophilic derivative. This suggests the presence of the CYP3A enzyme system and indicates that cytochrome CYP3A is responsible for the metabolism of ergotamine in beef animals.

Key Words: Ergot Alkaloids, P450, Liver

182 Metabolic responses of dairy cows to various subcutaneously administered dosages of glucagon. S. L. Oren, G. Bobe, B. N. Ametaj, A. F. Irlbeck, D. C. Beitz, and J. W. Young*, Iowa State University, Ames.

Continuous intravenous infusions of glucagon at 10 mg/d for 14 d improves the lipid and carbohydrate status of fatty livers in dairy cows; however, practical use of glucagon to treat or prevent fatty liver is likely to involve subcutaneous implants. We tested three subcutaneous glucagon dosages (2.5, 5.0, and 10.0 mg/d) on glucose, glucagon, and insulin in blood. Three cows were infused with each dosage of glucagon for 48 h in a 3 x 3 Latin Square with each cow being her own control, i.e., saline for 24 h before and after glucagon. Subcutaneous infusions of glucagon (SIG) caused plasma glucose to increase steadily for the first 8 h, especially with 5 and 10 mg/d. Average glucose concentrations remained elevated thereafter, but were greatest and most consistent for 5 mg/d. When SIG ended, glucose returned to baseline within 4 to 8 h. Plasma glucagon increased steadily and in a linear fashion for the first 8 h of SIG, and remained elevated during the 48-h infusions. The average increase was greatest for 5 mg/d (56%) compared with the 10 mg/d (47%) and 2.5 mg/d (31%) dosages. Once SIG ended, glucagon returned to baseline within 2 h. Plasma insulin was not affected by SIG except for an increase with 10 mg/d dosage during the first 8 h of SIG. Milk protein percentages decreased with increasing dosages of infused glucagon, whereas the concentration of other milk components and milk production were not affected in a dose dependent manner. In summary, subcutaneous infusions of glucagon into dairy cows caused the same general effects on plasma glucose, glucagon, and insulin and on milk production that we had observed with intravenous infusions. Therefore, practical administration of glucagon via subcutaneous implants for prevention or treatment of fatty liver is feasible in dairy cows. (Partly supported under CSREES-USDA agreement 99-35004-8576)

Key Words: Fatty Liver, Glucagon, Dairy Cows

183 Physiological responses of steers exposed to repeated sinusoidal heat challenge. M.J. Leonard*¹, D.E. Spiers¹, G.L. Hahn², K.J. Imhoff¹, and L.E. McVicker¹, ¹University of Missouri, Columbia, ²USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Summer heat stress continues to be a challenge to feedlot cattle production systems. Physiological indices are needed to predict thermal status of cattle and ultimately identify strategies to reduce stress. Twelve Angus x Simmental steers (Avg BW 419kg) were kept in environmental chambers and provided a typical finishing diet and water ad libitum. All steers were maintained in sinusoidal thermoneutral condition (TN; 19+/-7°C; 30-80% relative humidity) for 7 days. Air temperature (Ta) was then increased to a sinusoidal heat stress condition (HS; 33+/-7°C; 15-55% relative humidity) for 14 days. Thermal conditions were recorded continuously using data loggers (Onset Hobo), and included measurements of Ta and percent relative humidity (%RH). Temperature Humidity Index (THI) was calculated from these values. Steers were implanted intra-peritoneally with telemetric transmitters (Mini-Mitter, Inc.) to continuously monitor body core temperatures (Tcore). Skin

temperatures, respiration rates (RR), and rectal temperatures (Tre) were collected at 6am, 10am, 4pm, and 10pm daily. A second-order polynomial regression was the best fit for all relationships. Use of data from the 4 daily sample times showed that Ta was the best predictor for Tre (correlation coefficient(r)=0.64; $P < 0.0001$), RR (r =0.78; $P < 0.0001$), and skin temperatures (r =0.86-0.90; $P < 0.0001$). Continuous Ta and Tcore data was used to improve prediction of Tcore. Simultaneous records showed Tcore relationships to Ta and THI of r =0.63 ($P < 0.0001$) and r =0.75 ($P < 0.0001$), respectively. Analysis was improved using a Tcore lag of 3 hours relative to Ta, with increased correlation coefficients of 0.80 and 0.88 ($P < 0.0001$) for Ta and THI, respectively. These results show that it is possible to precisely predict thermal status of feedlot cattle using second-order polynomial regressions of ambient conditions.

Key Words: Cattle, Heat stress

184 Vitamin E supplementation in receiving diets: Effects on animal performance, medical treatment costs, and serum cholesterol concentrations. J.N. Carter*, D.R. Gill, T.C. Stovall, J.A. Shriver, B.A. Berry, W.T. Choat, A.W. Confer, R.A. Smith, and P.L. Claypool, *Oklahoma State University, Stillwater.*

Seven truckloads of shipping stressed calves (568 heifers, 197 ± 33 kg; 126 bulls and steers, 151 ± 11 kg) from Oklahoma and Texas auction barns were used to study the effects of adding 2000 I.U. of supplemental vitamin E (dl- α -tocopheryl acetate) for 0 (CON), 7 (E7), 14 (E14), or 28 (E28) days of a 42-day receiving period. Animals were blocked by weight into two classes (L=light; H=heavy) and randomly assigned to treatments within each class. Weights of each animal and whole blood samples from a subgroup in each class and treatment were obtained on d0, 14, 28, and 42. Serum was separated and frozen for later analysis of total serum cholesterol (SC) and serum vitamin E concentration (SE). Data were analyzed using GLM procedures of SAS; variables with statistical significance were further analyzed using MIXED. Regardless of treatment, average daily gain ($.95 \pm .36$ kg/d) and feed conversion ($F/G=5.3 \pm 1.1$) was not different, nor was performance different among weight classes (L vs H: $ADG=.97 \pm .35$ kg/d vs $.93 \pm .36$ kg/d; $F/G=5.09 \pm .31$ vs $5.46 \pm .31$). The percentage of calves identified as sick and thus requiring treatment with anti-microbial drugs was 67.7, 68.3, 61.8, and 60.3 percent for the CON, E7, E14, and E28, respectively. Medical costs (COST) decreased ($P > .05$) from CON by 12.8, 15.6, and 21.4 percent for E7, E14, and E28, respectively. COST was also analyzed as a ratio of COST/total gain on feed and revealed a significant ($P=.04$) response advantage for H calves (L= $\$3.83 \pm .03/100$ kg gain; H= $\$0.44 \pm .03/100$ kg gain). SC decreased significantly in L and H from d0 to d14 (L= -61.7 ± 5.5 mg/dl, $P < .0001$; H= -75.6 ± 5.1 mg/dl, $P < .0001$). SC increased slightly from d14 to d28 ($P > .05$) in both L and H. A recovery of SC at d42 was observed over d14 and d28, but d42 SC was still significantly lower than SC at d0 in both L and H calves (L= -41.65 ± 5.6 mg/dl, $P < .0001$; H= -61.82 ± 5.1 mg/dl, $P < .0001$). Previous vitamin E research indicates that stress reduced SE in a pattern similar to that shown by SC in this study; analysis of SE for this study is in progress.

Key Words: Vitamin E, Medical Costs, Cholesterol

185 A model of fescue toxicosis: effect of exposure time to endophyte-infected diet. P. A. Eichen*, M. S. Eibs, D. E. Spiers, G. Rottinghaus, and K. Fritsche, *University of Missouri, Columbia.*

A model of fescue toxicosis has been developed where rats consume a diet of endophyte-infected fescue seed (EIF) for several days prior to exposure to heat stress. We propose that simultaneous exposure to this diet and heat stress will produce even greater symptoms of fescue toxicosis due to onset of dual stressors. Telemetric transmitters (Mini-Mitter, Inc.) were surgically implanted in twelve 50 day-old, male rats to continuously monitor core body temperature (Tc). Rats were housed at thermoneutrality (TN; 21°C) and fed a diet containing endophyte-free fescue seed (EFF). After two weeks equilibration, they were randomly assigned to either EIF or EFF diets, and simultaneously exposed to heat stress (HS; 31°C) for 23 days. EIF diets were formulated to deliver ergovaline, the toxin in EIF, at $160\mu\text{g}/\text{kg BW}/\text{d}$. Body weight and feed intake were measured daily. Rats receiving EIF showed decreased feed intake ($P < .0001$) within one day of exposure to stressors, and decreased weight gains ($P < .001$) by day 3 of exposure. Average daily Tc was

higher for EIF-fed rats ($P < .0001$) by day 2 of exposure to dual stressors. These rats also had higher average daily maximum Tc throughout, reaching a peak of 40°C on day 3 of exposure. Daily maximum Tc for EFF-fed rats (39.6°C) only occurred on days 3 and 15. The major difference between EIF and EFF groups was in maximum daily Tc. In a previous study, animals received EIF at TN, one week prior to HS. Reduction in feed intake occurred upon introduction of EIF, and equaled the reduction in the present study during HS. Weight gains were also immediately decreased with EIF. Significant EIF-induced hyperthermia did not occur until day 3 of HS, with maximum Tc on day 6 (39.9°C). As in the present study, this remained in effect for the duration of HS. These results suggest that administration of endophyte-infected fescue seed before, or in conjunction with heat stress, has similar effects on performance and thermoregulatory ability.

Key Words: Fescue Toxicosis, Heat Stress, Rat

186 Effect of simulated dust on serum antioxidant status and lipid peroxidation of market stressed steer calves protected with or without prophylactic antibiotic. N. K. Chirase*¹, L. W. Greene¹, J. Avampato¹, C. W. Purdy², E. F. Walborg, Jr.³, Y. Xu⁴, and J. E. Klaunig⁴, ¹Texas Agricultural Experiment Station, Amarillo, ²USDA/ARS, Bushland, TX, ³Dermigen, Inc., Smithville, TX, ⁴Indiana University, Indianapolis.

Oxidative stress results when production of reactive metabolites of oxygen exceeds their safe disposal by antioxidant mechanisms. This study was designed to measure the oxidative stress status of market stressed steers exposed to simulated dust. One hundred and five crossbred steers (average BW 207 kg) were purchased in Newport, TN and transported to Bushland, TX. The simulated dust storm was produced by having cattle in an enclosed canvas tent. One half of the calves received Micotil[®] (1 ml/30 kg of BW s.c.) at Bushland. Calves were allotted randomly into three dust treatment groups: 1) Control (not exposed to tent and dust), 2) Tent (exposed to tent without dust) and 3) Dust (exposed to dust suspension inside tent). There were four dust application events, each lasting 1 h. Calves were weighed and blood samples taken in Newport (d 3), arrival (d 0) and approximately every 7 d for 28 d. All serum samples were used to measure serum antioxidant capacity (TACA) and lipid peroxidation (malondialdehydes or MDA). The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. There was no interaction ($P > .05$) between dust application and Micotil[®] for serum TACA or MDA concentrations. On d 1, serum TACA concentrations were greater ($P < .001$) for the control and tent groups than the dust group (4277, 4094 and 3506 IU/ml, respectively). Micotil[®] protected calves had greater ($P < .05$) serum TACA concentrations than controls on d 1 and 28. Serum MDA concentrations for the dust group was greater ($P < .05$) than the control and tent (37 vs 19 and 36 mcg/ml, respectively). Serum MDA concentrations were lower ($P < .02$) in Micotil[®] protected calves than the controls (22 vs 39 mcg/ml, respectively). These data suggest that more research is required to understand the role of oxidative stress on feeder cattle health.

Key Words: Steer calves, Dust, Antioxidants

187 Effect of dehydroepiandrosterone and dehydroepiandrosterone-sulfate on lymphocyte function. S.C. Lozano*¹, T.H. Welsh, Jr.², and J.C. Laurenz¹, ¹Texas A&M University, Kingsville, ²Texas A&M University, College Station.

Dehydroepiandrosterone (DHEA) and its sulfate conjugate, DHEAS, are the most abundant circulating adrenal steroids in primates, although their exact biological function is not understood. It is known that DHEA and DHEAS concentrations decrease with age and that supplementation of DHEAS can modulate immune function. However, little is known about the potential role of DHEA and DHEAS in livestock. This study investigated the effects of DHEA, DHEAS, and a synthetic glucocorticoid (dexamethasone, DEX) on Concanavalin A (ConA) induced lymphoproliferation and immunoglobulin (IgM) production by pig lymphocytes. Blood was obtained from male, crossbred pigs ($n=3$, 60 days of age) and lymphocytes obtained by density gradient centrifugation. Lymphocytes were plated at 1×10^5 cells/ml in DME/F12 containing 10% FBS, 2mM glutamine, 10 uM 2-mercaptoethanol, ConA (0 to 5 ug/ml), DHEAS (0 to 10^{-6} M), DHEA (10^{-6}) and/or DEX (10^{-8} M). Cultures were incubated for 96h and lymphoproliferation determined using the

Celltiter proliferation assay (Promega, Madison, WI). In replicate cultures, supernatants were removed and IgM production determined using an ELISA for pig IgM. ConA induced a dose-dependent increase ($P < .05$) in lymphoproliferation with maximal effects at 1.25 $\mu\text{g/ml}$. Although not effecting basal proliferation, DEX inhibited ($P < .05$) ConA-induced lymphoproliferation. In contrast, DEX inhibited ($P < .05$) IgM production at low ConA concentrations (0.6 $\mu\text{g/ml}$), but was unable to suppress IgM production at higher concentrations (1.25 $\mu\text{g/ml}$). Compared to studies in other species (mouse), DHEAS did not effect pig lymphocyte proliferation at any of the concentrations employed in this study. Similarly, DHEA (10^{-6}M) did not effect ($P > .05$) ConA-induced lymphoproliferation, IgM production or modulate the suppressive effects of DEX on lymphoproliferation. However, the addition of DHEA did reduce ($P < .05$) the suppressive effects of DEX on IgM production. These results indicate DHEA may be beneficial to reduce the suppressive effects of glucocorticoids on immune function. In addition, the ability of DHEA to modulate lymphocyte function combined with the apparent lack of activity of DHEAS supports the hypothesis that in vivo effects of DHEAS on lymphocyte function are dependent on sulfatase activity in other cells.

Key Words: Dehydroepiandrosterone, immunity, pig

188 Nitric oxide effects on rats fed an endophyte-infected seed diet. H. Al-Tamimi*, D. Spiers, and M. Ellerseick, *University of Missouri, Columbia.*

Fescue toxicosis impacts a wide sector of the livestock industry. Affected animals often experience increased hyperthermia during the summer. A major contributor to this problem is persistent peripheral vasoconstriction, which limits efficiency of heat loss from extremities. Nitric oxide has an opposite effect on peripheral vasculature, and might reduce effects of endophyte-infected tall fescue (EIF). Adult, male rats ($N=24$; 12 per trial; avg. bwt = 264.1 ± 20.1) were randomly assigned to 4 treatment groups (2×2 factorial). All animals were maintained at thermoneutrality (21°C) for 4 days followed by 20 days exposure to heat stress (31°C). Treatment diets began after 5 days at 31°C . Endophyte-free diet was fed to control and nitric oxide donor animals (120mg molsidomine/ml drinking water; M). Similar groups were fed EIF diets at 160 μg ergovaline/kg BW/day. Body weight, feed and water intakes were recorded daily. Core body temperature (Tcore) was monitored on an hourly basis using implanted telemetric transmitters (Mini-Mitter, Inc.). Serum was collected on the last day for blood profile analysis. Ingesting EIF increased Tcore at night ($P < .07$), and tended ($P = .13$) to raise it during the day compared to animals ingesting EIF-free diets. In contrast, M-treated animals had significantly ($P = .0001$) lower Tcore at night compared to M-free animals. Moreover, animals treated with combination of EIF and M had lower ($P = .003$) Tcore during the night than animals ingesting EIF alone. Feed intake of all animals decreased ($P = .0001$) at 31°C . Ingesting EIF caused a significant reduction in daily feed intake ($P = .003$),

daily gain ($P = .0001$) and feed efficiency ($P = .0001$). Even though molsidomine had no effect ($P > .47$) on these three variables, it significantly ($P < .02$) reduced daily water intake compared to M-free treated animals. The EIF diet caused a significant reduction in serum cholesterol and amylase ($P < .03$) levels, as well as serum alkaline phosphatase ($P < .07$) and phosphorus ($P < .05$). Results from the current study confirms increased hyperthermia due to EIF-ingestion. It also suggests that nitric oxide has an alleviating-effect on heat stress. Further studies are needed to examine this effect on livestock.

Key Words: Fescue toxicosis, Rat, Nitric oxide

189 Role of energy balance in the ability of lactating cows to respond to an intramammary infusion of endotoxin. K. H. Perkins, J. S. Liesman, and M. J. VandeHaar*, *Michigan State University, East Lansing.*

Dairy cows are in negative energy balance (NEB) around the time of parturition. This may contribute to the increased incidence of infectious diseases such as mastitis observed at this time. We hypothesized that cows in negative energy balance (NEB), compared to those in positive energy balance (PEB), would be less able to respond to and recover from an experimentally induced inflammatory response. To test this hypothesis, primiparous Holstein cows in early lactation (81 to 123 DIM) were placed on a restricted diet (NEB; $n=7$) or fed ad libitum (PEB; $n=7$) for 2 weeks. The NEB cows were fed at 80% of their predicted energy requirement with feed intake adjusted every 3 d. During wk 2 of the study, cows in NEB consumed 13 kg DM / d and produced 28 kg of milk / d resulting in calculated EB of -9 Mcal/d. Cows in PEB consumed 22 kg DM per day and produced 33 kg of milk / d for a calculated EB of 4 Mcal/d. At the end of the 2-week period one mammary quarter of each cow was infused with 100 μg of lipopolysaccharide (endotoxin) to generate an inflammatory response. From 0 to 6 h post-infusion, blood leukocytes decreased from 10^7 / ml to 3×10^6 / ml and recovered within 24 h. From 0 to 12 h, milk somatic cells in the infused quarter increased from 10^5 / ml to 7×10^6 / ml and remained elevated for at least 48 h, indicating trafficking of leukocytes from the circulation into the infused quarter. Dietary treatment had no effect on blood or milk cell numbers. Body temperature increased to 40.5°C by 6 h for all cows and returned to normal within 24 h. However, the initial increase in body temperature and subsequent decrease was more rapid in the PEB than NEB cows ($P = 0.03$). Respiration and heart rate increased in response to the infusion, and the increase was greater for NEB cows. In addition, the respiration rate of PEB cows returned to normal more rapidly ($P = 0.1$). We suggest that cows in positive energy balance may be able to respond to and recover from an inflammatory agent more rapidly than those in negative energy balance.

Key Words: energy balance, inflammation, mastitis

BEEF SPECIES

190 Age of calf at weaning of spring-calving beef cows and the effect on cow and calf performance and production economics. R. J. Rasby*¹ and R. T. Clark¹, ¹*University of Nebraska, Lincoln.*

Over a 5-yr period, spring calving cows were used in a carry-over design experiment to evaluate effects of calf age at weaning on cow and calf performance and economics. Management groups were early ($n = 60$, calf age 150 d, EW), traditional ($n = 60$, calf age 210 d, NW), and late ($n = 60$, calf age 270 d, LW). Cow body condition score (BCS) and weight at the last weaning date were different ($P < .05$) for EW (5.8, 583 kg), NW (5.5, 560 kg), and LW (5.2, 541 kg) groups. Pregnancy rate among groups were similar. Days on feed for groups differed ($P = .001$) and was 247 for EW, 204 for NW, and 164 d for LW steers. Average daily gain in the feedlot differed ($P = .01$) among groups and averaged 1.5 kg for LW, 1.4 kg for NW, and 1.3 kg for EW steers. Hot carcass weight was greater ($P = .01$) for EW (328 kg) and NW (332 kg) steers compared to the LW (321 kg) steers and fat depth was greater ($P = .05$) for EW and NW compared to LW steers. Percentage grading at least USDA Choice was greater ($P = .05$) for the EW compared to NW and LW groups. When carcass data for the NW and LW steers were adjusted to the same fat depth of EW steers, carcass data among groups were similar. Net income per steer at slaughter was greater (P

$< .001$) for the EW (\$75.36) and NW (\$62.16) steers compared to the LW (\$10.09) steers. Adjusting the carcass data to similar a backfat reduced differences in net income. Replacement heifer costs were greater ($P < .001$) for the EW compared to NW and LW heifers. Annual cow costs were greater ($P < .10$) for the LW (\$443.45) compared to the EW (\$410.09) and NW (\$421.35) groups. Breakeven for each system calculated on a steer financial basis was lowest for the NW and LW groups and greatest ($P = .08$) for the EW group. Age of the calf at weaning affects cow weight and BCS. Net income in each management system is influenced by cow costs, mo of the year and weight that steers calves are purchased into the feedlot and finished steers are sold, mo of the year cull cows are marketed, and replacement heifer development costs.

Key Words: Cow/calf Performance, Systems, Economics

191 The effects of age at weaning and prepubertal dietary management on performance of crossbred beef heifers. W. J. Sexten*, D. B. Faulkner, and F. A. Ireland, *University of Illinois, Urbana.*

Simmental \times Angus spring-born heifers ($n = 166$) were utilized in a 2×2 factorial arrangement to evaluate age at weaning and prepuber-

tal dietary treatment on performance, reproductive and maternal traits. Heifers were either early weaned (EW) at d 71±15.22 days of age or normal weaned (NW) at d 212 then placed on one of two prepubertal dietary treatments, restricted corn-based (RC) or forage based followed by *ad libitum* intake of identical concentrate diet (FOR). The corn-based diet was formulated to provide 3.064 Mcal NE_m/kg DM, 2.337 Mcal NE_g/kg DM and 17.3% CP (DM basis). Treatments ended at d 420 and heifers were artificially inseminated four days later. No differences in d 420 weights, hip heights (HH), or pelvic areas (PA) were attributed to age at weaning. The NW heifers were heavier, and had greater HH at d 507 (palpation) ($P < .05$). Restricted corn heifers were heavier (348.0 kg) had greater HH (122.62 cm) and greater PA (177.6 cm²) at d 420 than FOR heifers (305.3 kg), (119.12 cm) and (160.5 cm²) ($P < .05$). The RC heifers maintained a weight, and HH advantage at d 507 ($P < .05$). Feed efficiencies were greater for EW heifers (.203) compared to NW heifers (.175) and greater for RC heifers (.205) compared to FOR heifers (.177) ($P < .05$). No differences were observed in total ADG or ADG for the feeding period due to age at weaning. Total ADG was greater ($P < .05$) for RC heifers (.756 kg/d) versus FOR heifers (.630 kg/d). Conversely, FOR heifers had greater ADG during the feeding period (.996 kg/d) compared to RC heifers (.809 kg/d) ($P < .05$). There were no differences in percent cyclic at days 311, 380 or 420 between treatments. Differences in pregnancy at palpation (83 days post AI) attributed to diet were observed, where 85.23% of RC heifers were bred compared to 58.98% of FOR heifers ($P < .05$). No differences in mortality were observed, but FOR heifers experienced 11.79% greater incidence of morbidity ($P < .05$). Early weaning may provide an alternative method for replacement beef heifer development, however heifer performance can be influenced by prepubertal dietary treatment.

Key Words: Early weaning, Heifer development

192 Early-weaning and nutritional management affect feedlot performance, carcass merit, and rate of intramuscular and subcutaneous fat deposition of Angus x Simmental heifers. A. E. Wertz*¹, L. L. Berger¹, P. M. Walker², D. B. Faulkner¹, and F. K. Mc Keith¹, ¹University of Illinois, Urbana, ²Illinois State University, Normal.

Early-weaned Angus x Simmental heifers were used to determine the effects of post-weaning nutritional management on feedlot performance, carcass merit, and rate of intramuscular and subcutaneous fat deposition of heifers fed for a high quality market. Sixteen heifers were weaned at 73±5.9 d of age and grazed on endophyte-infected tall fescue for 19 months prior to entering the feedlot (EWP). Eighty heifers from the following year's calf crop were weaned at 71±5.9 d of age and allotted to either *ad libitum* haylage-soybean hulls (EWH) or limit-fed concentrate (EWC) to achieve a similar rate of gain as the EWH heifers. Following 119 d on the growing diets, 16 EWC and 16 EWH calves were paired based on weight and growth rate and individually fed during the finishing period along with the EWP heifers. Ultrasound measurements of subcutaneous and intramuscular fat were recorded at ~60-d intervals throughout the finishing period. These data were regressed over time to evaluate the pattern of intramuscular and subcutaneous fat deposition as affected by nutritional management. Despite similar rate of gain, EWC calves gained more efficiently ($P \leq .05$) than EWH calves in the feedlot. Heifers finished as two-year-olds (EWP) tended ($P \leq .12$) to gain faster but gained less efficiently ($P \leq .01$) compared to EWC heifers finished as calves. The rate of subcutaneous and intramuscular fat deposition was similar among EWC and EWH heifer calves. Subcutaneous fat intercept was higher ($P \leq .01$) and deposition was quadratic ($P \leq .01$) for two-year-old heifers, compared to heifer calves that deposited subcutaneous fat both linearly ($P \leq .01$) and quadratically ($P \leq .01$). Intramuscular fat intercept was also higher ($P \leq .01$) for two-year-old heifers, however, heifers finished as calves deposited intramuscular fat at twice ($P \leq .01$) the rate of the two-year-olds. These data suggest that heifers finished as calves tended to gain slower but gained more efficiently in the feedlot and deposited intramuscular fat at twice the rate of two-year-old heifers.

Key Words: Early-weaned heifers, Marbling, Ultrasound

193 Weaning management strategies for steer calves. R. S. Wells, D. B. Faulkner, and F. A. Ireland, University of Illinois at Urbana/Champaign, Illinois.

This study was designed to evaluate the effects of limit feeding on performance and carcass traits of early weaned steers. Angus cross steers

(144 hd, 77±18 d, 89±16.9 kg) were allotted to four treatments: early-weaned (EW), early-weaned limit fed (d 0-128, EWLIM), creep fed (d 0-128, CF), or normal weaned (NW). Pens consisted of 7 heep per pen and 6 pens per treatment. All treatments were placed on a common finishing diet at d 128. The EW steers had a higher rate of gain than did the EWLIM steers during the finishing phase ($P = .03$, 1.15 vs. 1.04 kg). The CF steers had higher ADG than the EWLIM steers during the finishing phase ($P = .0001$, 1.29 vs. 1.04 kg) and the NW steers had a higher ADG than the EW steers ($P = .0001$, 1.33 vs. 1.15 kg). The EWLIM steers high the best feed efficiency of all treatments during the finishing phase ($P < .03$, .208 vs. .173, .175, .170, respectively for EW, CF, NW). The EWLIM steers consumed the least amount of total concentrate during the finishing phase ($P < .04$, 1842, vs. 2308, 2125, 1901 kg/pen, respectively for EW, CF, and NW). Back fat was used as a covariate for carcass data analysis. No differences were observed for marbling (900 = select, 1000 = choice, and 1100 = av. choice) for all treatments (1142, 1146, 1104, 1163, respectively). No differences were observed for REA across all treatments (76.43, 75.15, 77.22, 77.12 cm², $P > .05$, respectively). The NW steers had the highest percentage of kidney, pelvic, and heart fat ($P < .005$, 2.69 vs. 2.07, 2.39, 2.05 respectively for EW, EWLIM, and CF). No differences of HCW were observed across all treatments (285, 288, 289, 294 kg, $P > .05$, respectively). Feed efficiency and ADG of EW steers was lower than previously observed during the first two periods of the study. This may have depressed initiation of marbling for the EW treatment could possibly explain why there were no differences in this study. This is in contrast to findings of other early-weaning studies. In this study, EWLIM steers had the best feed efficiency and second highest marbling score.

Key Words: Early Weaning, Beef, Steers

194 Implant strategies in an integrated beef production systems. S. K. Duckett*¹ and J. G. Andrae¹, ¹University of Georgia, Athens.

Anabolic implants are routinely used to lower the cost of beef production. On average, implants increase average daily gain by 18%, improve feed efficiency by 8%, and increase carcass weight by 5% in the feedlot. Implants have also been implicated in the reduction of carcasses grading Choice. However, the change in marbling score with implanting is variable and appears related to increases in ribeye area that accompany implant administration. Other factors related to implant effects on marbling are: days to harvest after last implant (+) and number of implants used (-). Numerous implant products and combinations are available today; however as systems are devised for integrated beef production, implant strategies must be optimized to reduce cost of beef production and minimize effects on end-product quality. Specifically, the production system utilized and the time of year that the cattle are marketed are most important in determining the implant strategy used. In calf-fed systems where animals are harvested in early spring at 12 to 14 mo. of age when the Choice/Select spread is low, the implant strategy can be very aggressive to include several implants from 2 mo. of age to harvest. Conversely, in systems where cattle are backgrounded on forages and harvest occurs in summer months when Choice/Select spread is high, implant strategies should be more conservative to reduce losses due to changes in product quality. In summary, implant strategies for integrated beef production systems should be determined based on the time of marketing to optimize returns for reducing feed costs and maintaining carcass quality.

Key Words: Beef, Implant

195 A comparison of lifetime implant strategies on production and carcass characteristics in steers. R.H. Pritchard¹, K.W. Bruns*¹, and C.P. Birkelo², ¹South Dakota State University, Brookings, ²Schering Plough Animal Health.

Crossbred steers from two sources (n=310) were used to evaluate the influence of lifetime implant strategies (LIS) on production efficiencies and carcass traits. Implants, if used, were administered at: 2 mo of age, weaning, end of backgrounding phase, and 70 d into the finishing phase using four LIS as follows: Control (C), no implants used; Low Potency (LP), Ralgro, Ralgro, Ralgro, Magnum; Intermediate Potency (IP), Ralgro, Ralgro, Ralgro, Magnum plus Component TS; or High Potency (HP), Synovex C, revalor-g, Synovex-S, and revalor-s, respectively. Cattle were reared on native range pre-weaning. Days on feed were constant within source and across LIS. Backgrounding (100 d) and

finishing (132 or 150 d for sources 1 and 2) diets contained .88 and 1.35 Mcal NE_g/kg. Treatment did not affect BW at weaning (233+3.0 kg) or after backgrounding (321+3.6 kg), although backgrounding ADG was higher (P<.05) for LP and HP (.98 and 1.01 kg) than C (.93 kg). During finishing, implanting (C vs implanted) improved (P<.05) ADG (1.40 vs 1.61 kg), DMI (9.97 vs 10.69 kg) and G/F (.156 vs .167). Dressing percent was greater (P<.05) for HP vs C, LP, and IP (61.7, 62.1, 61.9, 62.9). Carcass weight (318, 337, 341, 348 kg), and LDA (79.0, 80.3, 82.3, 84.5 cm²) increased (P<.05) linearly with increasing LIS potency. Control steers had less (P<.05) rib fat than implanted steers (.21 vs .24 cm). Marbling scores (5.68, 5.54, 5.38, 5.38) were lower (P<.05) for IP and HP treatments than C. Implanting advanced (P<.05) bone maturity scores over C (A⁴⁷ vs A⁶¹). Shear Force (4.02, 3.84, 4.06, 4.15 kg) was greater (P<.05) for HP vs LP, but LIS did not cause a linear shift (P>.10) in shear force. There were no source x LIS interactions detected for carcass traits. The results of this study suggest that lifetime implant strategies can be used to optimize production efficiencies for a specific set of conditions without compromising carcass acceptability.

Key Words: Beef, Implants, Tenderness

196 Implant strategy influence on rate of marbling, carcass characteristics, longissimus tenderness, and blood metabolites of early-weaned crossbred steers. R. E. Robb*, D. B. Faulkner, and F. A. Ireland, *University of Illinois, Urbana.*

Early-weaned Angus x Simmental steers (n = 282; 56 ± 19 d of age) were blocked by body weight and randomly allotted to implant treatments (trt) to evaluate the effects of implant strategy on performance, rate of marbling, carcass characteristics, longissimus tenderness, and blood metabolites. Implants used were ;Component E-S (E-S; 200 mg USP progesterone + 20 mg estradiol USP, Component TE-S (TE-S; 120 mg trenbolone acetate + 24 mg estradiol USP), and Encore (43.9 mg estradiol). Treatments consisted of three successive implants administered at d 0, 98, and 196: A) Non-implanted control B) E-S/E-S/TE-S, C) E-S/TE-S/E-S, D) TE-S/E-S/E-S, E) TE-S/TE-S/TE-S, and F) Encore/TE-S. Calves were allowed ad libitum access to a high concentrate finishing diet for 327 d. Ribeye area (REA), 12th rib fat (RF), and marbling scores (MS) were monitored by ultrasound on d 146, 195, and 242. A sub-sample of longissimus muscle (LM) steaks (n = 72) taken from the 12th and 13th ribs were aged 4 d, and then prepared for Warner-Brazler shear force evaluation. Each steak was classified as "tender," "intermediate," or "tough" if its LM shear value was < 6 kg, 6 to 9 kg, or >9 kg, respectively. Control steers had lower DMI and lower ADG than all other trt (P < .05). Trt E improved gain:feed compared to B, C, and D (P < .05). Ultrasound MS were not different among trt. In addition, no differences were observed between control and all other trt for RF, MS, percent cooking loss, average shear values, moisture, extractable fat, yield grades, and quality grades. However, control steers had lower hot carcass weights, smaller REA, and greater kidney, pelvic, heart fat than all other trt (P < .05). Trt B resulted in greater REA than trt C and D (P < .05) and more carcasses graded average choice than trt D (P < .05). Trt B and F had MS that were not different, however, F resulted in 47% more "tender" steaks than B (P < .05). Trt E was more efficient (P = .04) and resulted in HCW, REA, tenderness data that was not different from B, C, and D, but reduced MS and quality grade when compared to B, C, and D (P < .05).

Key Words: Early-wean, implant, beef

197 Experiences of the study for sustainable development of beef cattle production. F. Szabo*, E. Zele, P. Polgar, Z. Wagenhoffer, and Z. Lengyel, *University of Veszprem, Georgikon Faculty of Agriculture, Department of Animal Husbandry, Hungary.*

On-farm research was carried out for five years on peat bog soil pasture in Hungary for sustainable development of beef cattle production. The

aim of the study was to gain some basic data about herbage production from peat bog soil pastures and animal performance resulting from their use by beef cows herds of different genotypes. Monitoring and study was carried out in three farms with both native and seeded grasslands for suckler cows. Each of the herds was composed of Hungarian Simmental (HS), Hereford (HE), and HSxHE crossbred cows (F1 and R1 generations, number from 80 to 310 heads/farm/year/genotype). Herds were kept outdoors all year round and cows mated in summer, the spring born calves being weaned in autumn. Significant differences were observed in reproduction and weaning performances between HS and HE cows. Calving rate was 79.3%, and 82.6%, survival rate to weaning 97.6% and 91.3%, and 205-day weaning weight 193.2kg and 173.6kg respectively. There were significant heterosis effect in the case of crossbred cows (F1, R1) in both calving rate (+ 9.7 % and + 5.7% respectively), and the survival rate of F1, R1 and R2 calves (+6.3%, +3.5%, +0.7% respectively). Annual herbage production differed significantly between years, farms and pasture types. The range in variation was from 2.82 to 3.42 tonnes/ha for dry matter, from 27.8 to 34.4 thousand MJ/ha for metabolisable energy and from 3.85 to 6.15 kg/ha for crude protein. Calculated from the average dry matter annual production yield and cows requirements, the annual carrying capacity of the pastures studied ranged from 55 cows/100ha for the large size HS to 66 cows/100ha for the smaller size HE. The highest calf crop (50.7 weaned calves and 9.6 tonnes total weaning weight) was obtained in the case of F1 cow herds while the lowest (42.6 and 8.23 respectively) in the case of HS.

Key Words: beef cattle, pasture yield, stocking rate

198 Effects of early-weaning and nutritional management on feedlot performance, carcass merit, and rate of intramuscular and subcutaneous fat deposition in Angus and Wagyu heifers. A. E. Wertz*, L. L. Berger¹, P. M. Walker², D. B. Faulkner¹, and F. K. McKeith¹, ¹University of Illinois, Urbana, ²Illinois State University, Normal.

Twelve Angus (A2Y) and 12 Wagyu-cross (1/2 Wagyu x 1/2 Angus) (W2Y) were weaned at 180 d of age and grazed on endophyte-infected tall fescue for 16 months prior to entering the feedlot. Twelve Angus (AC) and 12 Wagyu-cross (WC) heifers from the following year's calf crop were weaned at 142 ± 4.3 d of age and immediately adjusted to an 80% concentrate ration. All heifers were individually fed a common finishing diet until it was estimated that 50 percent of their respective group would grade USDA low prime or better. Ultrasound measurements of subcutaneous and intramuscular fat deposition were recorded at ~60-d intervals throughout the finishing period. These data were regressed over time to evaluate the pattern of intramuscular and subcutaneous fat deposition as affected by breed and post-weaning nutritional management. As two-year-olds, Angus and Wagyu-cross heifers gained at a similar rate and efficiency. Subcutaneous fat increased linearly (P<.01) during the finishing period for both A2Y and W2Y heifers. However, A2Y heifers had a higher subcutaneous fat intercept (P<.01) than W2Y heifers. Wagyu two-year-olds had a higher intramuscular fat intercept (P<.01) compared to A2Y heifers and intramuscular fat deposition increased both linearly and quadratically (P<.01) for W2Y heifers. In contrast, the increase in intramuscular fat was linear (P<.01) among A2Y heifers. Wagyu heifer calves gained at a similar rate but less efficiently (P<.05) than AC. Subcutaneous fat deposition was similar among AC and WC and increased in both a linear and quadratic (P<.01) manner. Intramuscular fat deposition increased linearly (P<.01) among both the AC and WC heifers. However, WC had a higher (P<.01) intramuscular fat intercept than AC. Wagyu genetics improved intramuscular fat deposition. However, efficiency of gain was compromised among Wagyu heifer calves finished in the accelerated program.

Key Words: Wagyu, Early-weaned, Ultrasound

BREEDING AND GENETICS

199 Evaluation of lifetime production of top cows in different dairy breeds. M. Horvai-Szabo¹, J. Dohy*¹, and G. Hollo¹, ¹*Szent Istvan University, Godollo, Hungary.*

Due to recent achievements of biotechnical methods, best animals might have an important role for being embryodonors or cell nucleus donors. For this purpose, top cows of different dairy breeds with high lifetime production have been analyzed, in order to find correlation breakers (high protein yield combined with moderate milk quantity). Yields from different breeds were analyzed as follows: Swiss Simmental (n=241), Brown Swiss (n=52), Osnabrck Holstein-Friesian (n=47), Hungarian Holstein-Friesian (n=22), German Black and White (n=15), German Red and White (n=9), and Danish Jersey (n=22). Lifetime milk production of all cows but Danish Jersey and Swiss Simmental ones, exceeded 100000 kg. Traits studied were as follows: total milk yield (kg), total milk protein and butterfat production (kg), milk protein and butterfat percentage. Cows were ranked on milk protein yield (kg). Ranking of Danish Jersey individuals was made on butterfat yield (kg) and rank correlations were calculated on milk and protein (in Jersey on milk and fat) yield. The probability of appearance of correlation breakers was also tested according to the deviation from the mean based on age, milk and protein production. For Swiss Simmental and Brown Swiss breeds it was found that the lower the protein production is, the lower is the correlation. In the first Osnabrck Holstein-Friesian subpopulation high coefficient of correlation (0.74) was calculated, which was not the case in the other two ones. The share of the correlation breakers in the three subpopulations was 12.5%, 33.3% and 56.3%, resp. In German Black & White and Red & White, similar and high coefficients of correlation were present (0.9 and 0.84, resp.). The share of the correlation breakers was 26.7% and 22.2%, resp. In the Hungarian Holstein population the coefficient of correlation was low (0.29). Consequently, the ratio of correlation breakers is relatively high. The value of the rank correlation coefficient between milk fat and milk yield of Jersey top cows was 0.26 that also means a weak relationship. The ratio of the correlation breakers was 36.4%. In conclusion is: the lower is the coefficient of rank correlation, the higher is the chance for appearance of correlation breakers.

Key Words: Lifetime milk production, Correlation breakers, Dairy breeds

200 Analysis of plasma IGF-I hormone levels in Holstein-Friesian heifers. M. Horvai-Szabo¹, R. Renaville², and J. Dohy*¹, ¹*Szent Istvan University, Godollo, Hungary,* ²*Faculté des Sciences Agronomiques, Gembloux, Belgique.*

Genetic progress in animal breeding is determined by efficiency of selection. In addition to small genetic progress to be expected problems may arise from the time factor. For this reason, analysis of one of the physiological-genetic parameters, which has an effect on performance traits would be needed in the early part of life. The aim of this experiment was to determine the IGF-I level in Holstein-Friesian heifers as a physiological-genetic parameter from birth until 14 months of age. For this purpose animals were kept under the same environmental conditions. They, however, had different genetic background. During the experiment blood samples (10 ml) were collected from 100 heifers every month. Due to losses statistical analysis was made only for 86 individuals. All samples were centrifuged at 2000 x g for 20 min. at 4°C, and stored at -20°C for subsequent analysis. Concentrations of IGF-I in plasma samples were determined by (¹²⁵I)RIA procedure according to Lemal et al. (1989). Findings reveal higher IGF-I concentrations in plasma (42.84 ng/ml) (P<0.05) at birth than two months later (15.44 ng/ml). The IGF-I hormone level, however, seemed to increase thereafter at 3, 4, and 5 months of age. Moreover, it exceeded even the initial value at 6th month of age (61.45 ng/ml) (P<0.01). Although, the IGF-I concentrations in plasma showed slight decrease by 7, 8 months with slight ascending phase at 13 and 14 months of age. But these values remained still above the initial value. Peak value at 6 month suggests average age at precocity. IGF-I concentrations in plasma reached their maximum at 12 month of age (82.25 ng/ml) an increase of 100 % in comparison to the initial value (P<0.01). Both sexual maturity, and precocity depends on the state of development of the individual. For this reason, blood collection and body weight of the animals were measured simultaneously. In order to be able to answer the question if there is any correlation between the variation of the hormone level and precocity, the IGF-I concentrations and the variation of body weight were

analysed. It can be stated that, the type of the variation of IGF-I concentrations in plasma followed the tendency of the variation of age and body weight.

Key Words: IGF-I, Sexual maturity, Dairy heifers

201 Results of a simulated selection using markers in dairy cattle with respect to longevity traits. G. Freyer*¹, L. Panicke¹, and G. Erhardt², ¹*Research Institute for the Biology of Farm Animals,* ²*Justus Liebig University Giessen.*

A study where two Casein loci were used to be markers for improving milk yield, fat content and protein yield in a marker assisted selection experiment focused on side effects which possibly may happen on longevity traits. The traits of interest to be selected on are the milk traits. The influence on longevity traits is indirectly taken into account. Using the complete information on two samples of Black and White cows of 974 and 454 individuals a simulation on the data was carried out evaluating the selection differences in period of use, period of life and production of the whole life. The selection criteria were chosen flexible using one of the milk production traits each as well as marker information. During the investigated period no negative effect of simulated selection using EBV for milk yield, fat content and protein yield alone or in combination with the marker information on the longevity traits occurred in the population. There are no significant differences caused by selection on pure EBV and MAS within a trait. Combinations of heterozygous genotypes at more than one Casein locus affect the longevity traits positively.

Key Words: Dairy cattle, marker assisted selection, longevity

202 Relationships between parameters of the glucose tolerance test (GTT) in young sires and their estimated breeding values (EBV). L. Panicke*¹, R. Staufenberg², O. Burkert², E. Fischer³, and F. Reinhardt⁴, ¹*Research Institute for the Biology of Farm Animals, Dummerstorf, Germany,* ²*Free University Berlin, Institute of Veterinary Physiology, Germany,* ³*University of Rostock, Faculty of Agricultural and Environmental Sciences, Germany,* ⁴*United Datasystems for Animal Production, Verden, Germany.*

A high milk performance connected to a sound health regarding metabolism and a sufficient fertility in dairy cows depends on a well balanced distribution of energy in the body. Insulin plays an outstanding role based on its central position in energetic metabolism. The function of insulin may be recorded by means of the intravenous glucose tolerance test (GTT). The reaction of insulin and glucose was investigated after infusion of 1 g Glucose per kg^{0.75} because of the probable genetic determination of the reactive ability. The coefficients of heritability range from $h^2 = 0.16 \pm 0.10$ to $h^2 = 0.28 \pm 0.16$. The relationship between GTT-parameters and estimated breeding values (EBV) depends on the age. Investigating 28 sires the correlation coefficients amount to $r = 0.5$ for parameters of GTT and estimated breeding values (EBV) which is closer than those between pedigree breeding value (PBV) and GTT. This is expecting additional information for young sires before the insert of the test.

Key Words: young sires, glucose,insulin, breeding value

203 Realized advantages of progeny testing young dairy bulls in multiple countries. N.R. Zwald* and K.A. Weigel, *University of Wisconsin, Madison.*

The objective of this study was to determine the extent of multiple country progeny testing and to examine the effects on reliability and marketability of these bulls. Holstein Bulls born between 7/1/92 and 12/31/94 were used; giving a set of bulls that had only first crop daughters. August 1999 Interbull evaluations were used to examine reliabilities in sampled countries vs. non-sampled countries. For each bull, home country was the country of registration if he had daughters there; otherwise it was the country with the most daughters. From the initial set of 11,862 bulls, 563 were sampled in at least two countries. Canada, Germany, France, Netherlands, USA, New Zealand, and Australia had the most extensive multiple country progeny test programs. The USA, Canada, France, and Netherlands were the most common home countries, while Germany, New Zealand, Australia, and France were the most frequent countries of foreign sampling. Mean production reliabilities for

multiple country sampled bulls were 0.905 in the "home" country, 0.891 in foreign countries where the bull was sampled, and 0.779 in countries with no daughters. Reliability for teat placement was 0.865 in countries where a bull was sampled, and 0.822 in countries with no daughters. Reliability for rear udder width was 0.828 in countries where a bull was sampled, compared to 0.683 in countries where a bull was not sampled. The advantages of multiple country progeny testing were realized to a larger extent for countries that had low genetic correlations between production systems (e.g. US and New Zealand), and for type traits that were measured differently between countries. Marketing advantages also existed for bulls with daughters in multiple countries and thus higher reliability values. International sampling is increasing in popularity, and this should improve the accuracy of international sire evaluations in the future.

Key Words: Progeny testing, International evaluation, Reliability

204 Early prediction of 305 days milk production using an empirical Bayes method. J.A.C. Pereira*¹, M. Suzuki¹, K. Hagiya¹, and Y. Atagi², ¹Obihiro University of A & VM., Obihiro, Japan, ²National Livestock Breeding Center(Ministry of Agriculture Forestry and Fisheries), Fukushima, Japan.

The objectives of this study were 1) to predict the future milk production from early records of the lactation using an empirical Bayes method (EBM), and 2) to compare the EBM against the Test Interval method (TIM), Best Predicted estimation (BPE), and Wood's model (WM). Daily milk yields were from 606 first lactation Japanese Holstein cows in three herds. From each file of 305 daily records, 10 random samples with an interval of one month approximately were taken. The accuracies of the methods were compared using the absolute difference (AD) and the standard deviation (SD) of the differences between the actual and the estimated 305-d milk production. The results showed that in the early stage of the lactation, EBM was superior in obtaining the prediction with high accuracy. When all the herds were analyzed jointly, the AD during the first 5 samples were on average 373, 590, 917, and 1042 kg for EBM, BPE, TIM, and WM, respectively. Corresponding SD for EBM, BPE, TIM, and WM were on average 488, 733, 747, and 1605 kg. When the herds were analyzed separately, the EBM predictions retained its high accuracy. In contrast, TIM and BPE exchanged the results of their predictions; TIM obtained better accuracies in one of the herds. When more information on the actual lactation was added to the prediction, TIM and WM gradually achieved better accuracies in the predictions. Finally, in the last period of the lactation, both of the methods overwhelmed EBM and BPM. The AD for the last 2 samples analyzing all the herds jointly were on average 141, 142, 164, and 214 kg for WM, TIM, EBM, and BPE, respectively. In the current practices of collecting monthly records in Japan, early prediction of the future milk production may be more accurate using EBM. Alternatively, if enough information of the actual lactation is accumulated, TIM may obtain better accuracy in the latter stage of lactation.

Key Words: Empirical Bayes method, Daily milk yields, Absolute difference

205 Heritability and genetic correlation for lifetime production and first lactation traits of Holstein cows in Japan. K. Hagiya*¹, M. Suzuki¹, J. A. C. Pereira¹, and T. Kawahara², ¹Obihiro University of A & VM, Obihiro, Japan, ²Hokkaido Dairy Cattle Milk Recording and Testing Association, Sapporo, Japan.

Heritabilities and genetic correlations for 33 traits in cows' lifetime and first lactation were estimated and compared. Data consisted of 132,096 animals in a pedigree sub-file and 58,352 records. Herd life and productive life for longevity traits; and milk, fat, solid nonfat, and protein for lifetime production traits; in 48 and 84 months each, were 12 of the traits. Milk, fat, solid nonfat, protein, and 17 type traits in the first lactation were also investigated. Variance components for all the traits were simultaneously estimated using EM-REML with a multiple-trait animal model. Inbreeding coefficients of parents were calculated from a pedigree file containing more than 2,000,000 animals. An additive relationship matrix with the inbreeding was used to account for bias in variances. For all traits, heritabilities were higher (0.01 to 0.08) when considering the inbreeding than when not considering it. Heritabilities of lifetime production traits (0.19 to 0.20) were higher than those of longevity traits (0.13 to 0.16). Genetic correlations between milk productions in the lifetime and first lactation were 0.69 and 0.53 for 48

and 84 months, respectively. Genetic correlations between 84-mo milk production and type traits in first lactation ranged from -0.28 (capacity and strength) to 0.33 (mammary system). These genetic correlations could be used to predict genetic values for lifetime production traits from records of milk production and type traits in first lactation. The selection for capacity or related traits may decrease lifetime production.

Key Words: Holstein cows, Lifetime production, Genetic parameters

206 Method R estimates of heritability and repeatability for milk, fat, and protein yields of Japanese Holstein cows. M. Suzuki*¹, K. Hagiya¹, J. A. C. Pereira¹, and T. Yoshizawa², ¹Obihiro University of A & VM, Obihiro, Japan, ²National Livestock Breeding Center(Ministry of Agriculture Forestry and Fisheries), Fukushima, Japan.

Estimates of heritability and repeatability for 305-d milk, fat, and protein yields were calculated from records of Holstein cows used for national sire genetic evaluations in Japan. Data included 5,772,159 records and 2,170,997 cows for milk and fat yields, and 3,745,913 records and 1,539,187 cows for protein yield. Data were adjusted to 26 months of age in the first calving. Variance components were estimated by Method R, which uses iteration on data and second-order Jacobi iteration for obtaining solutions to the mixed model equations. The whole data and ten different random subsets from the data were used for parameter estimation. Heritabilities estimated from the ten subsets were on average 0.34, 0.32, and 0.30 for milk, fat and protein yields, respectively. These heritabilities were higher by 0.01 than those estimated from the whole data. Repeatabilities were 0.53, 0.52, and 0.51 for milk, fat, and protein yields, respectively. The mean of approximate standard errors of heritabilities and repeatabilities ranged from 0.003 to 0.004, and from 0.001 to 0.002. When the analysis was performed by parity, the results were different among parities. Heritability estimates for all the traits were 0.40, 0.37, and 0.32 for milk, fat, and protein in the first lactation, respectively, and decreased in the following lactations. These estimates in the latter lactations were similar to the results obtained when the whole data set was used in this analysis. If genetic evaluations are performed without taking account of the disagreement among the first and following lactations, negative impact on the accuracy of the evaluations could be encountered. Now that more powerful computers are available, sire genetic evaluations may be more accurate if the first and following lactations are treated as different traits.

Key Words: Method R, Heritability, Repeatability

207 Analysis of breeding efficiency in relation to dairy performance in Holstein cows. E. Szücs*¹, K. Bódis², A. Gáspárdy¹, I. Györköcs³, J. Tözsér¹, and Gy. Látits¹, ¹Szent István University, Gödöllő, Hungary, ²Technische Universität München, Freising/Weihenstephan, Germany, ³Research Institute for Animal Breeding and Nutrition, Herceghalom, Hungary.

In order to be able to characterize reproductive performance in dairy cattle attempts have been made using the term Breeding Efficiency developed by Tomar (1965). Breeding efficiency was defined by the formula $BE = [365(n-1)+740] \times 100 / (AC+CI)$, where n is the number of calving intervals, 365 is the desired calving interval in days, 740 is the desired age at first calving in days, AC is the actual age at first calving and CI is the sum of the actual calving intervals in days. Database of representative sample from an upgrading program with Holstein-Friesian was used in this study (N=28631). Statistical analysis was made by SAS PC-Version, Release 6.04. (1996) using GML Type III, ANOVA, and multivariate regression analysis (backwards stepwise procedure). LSMs for BE seemed to improve from first to sixth calvings. Values for subsequent parities were 91.8; 92.9; 94.6; 94.7 and 96.4 %, respectively. BE can be estimated with high precision and relatively low standard error. Coefficients of determination were $R^2 = 0.99$ or even higher with $SE = 0.67-0.17$ ($P < 0.001$) for different parities. Medium and negative relationships of BE with CI were calculated. Coefficients of correlation seemed to decrease for subsequent calvings ($r = -0.50$ and $r = -0.36$, $P < 0.001$). Closer and negative coefficients of correlation of BE with AC ($r = -0.87$ and $r = -0.96$, $P < 0.001$) and relatively low and negative relationships of BE with actual lactation milk yield, butterfat yield and milk protein yield were established as follows: $r = -0.12$ ($P < 0.05$); $r = 0.15$ ($P < 0.01$) and $r = -0.16$ ($P < 0.01$), respectively. Relationships of BE with butterfat as well as milk protein percentage seemed to be low and negative ($r = -0.08$, $P > 0.05$ and $r = -0.17$, $P < 0.05$). In conclusion,

the term "breeding efficiency" proved to be a useful tool for evaluation of reproductive performance in dairy cattle.

Key Words: Breeding Efficiency, Dairy and Reproductive Performance, Dairy cattle

208 Feet and leg structures associated with changes in productive life in dairy cows. P. O. Boisot* and R. D. Shanks, University of Illinois, Urbana.

Feet and legs have an impact on productive life (PL), but only extreme scores for these traits should increase involuntary culling. The objective of our research was to identify ranges of feet and leg structures associated with greater or less expectancy in PL. Type score during first lactation, milk deviation and PL on 49,601 Illinois cows born from 1979 to 1993 were provided by Holstein Association and USDA. An analysis of variance on PL was carried out, adjusting for the fixed effects of herd-year of first calving, age at first calving, herd status and one of the three linear feet and leg traits (rear legs-side view (RLSV), rear legs-rear view (RLRV) or foot angle (FA)). Each feet and leg trait was pre-adjusted for age at first calving, classifier and stage of lactation before being divided into 10 groups of 5 point intervals (group 1 for scores 1 to 5, group 2 for scores 6 to 10, . . . , group 10 for scores 46 to 50). Milk deviation and PTA somatic cell score were fitted as covariates in order to adjust PL for voluntary culling and mastitis. For RLSV, cows scoring between 1 to 10 and 41 to 50 points had a decrease in PL of 2.32 ± 0.41 mo compared to other cows, expected PL in interval 41 to 50 was lower by 1.91 ± 0.80 mo compared to expected PL in interval 1 to 10. Cows scored in interval 1 to 30 had a decrease in expected PL of 2.67 ± 0.44 mo for RLRV and of 2.50 ± 0.34 mo for FA compared to other cows. The decrease in PL was accentuated in interval 1 to 10 with a difference of 3.68 ± 0.39 mo for RLRV and 2.75 ± 0.39 mo for FA compared to interval 11 to 30. Dairy producers should only consider feet and legs in their voluntary culling criteria when cows have scores below 11 points for RLSV, RLRV or FA or above 40 points for RLSV. Other feet and leg scores on first lactation were not justified as criteria in deciding whether or not a cow should be kept in the herd. Our conclusion assumed that differences in PL reflected the real biological relationship between feet and legs with longevity rather than culling practices based solely on scores for feet and legs.

Key Words: Culling, Feet and legs, Longevity

209 Predicting losses due to mastitis. C.M. Wachter* and B.T. McDaniel, North Carolina State University, Raleigh.

Objectives were to evaluate number of cases of mastitis as a predictor of 1) deviation between predicted and actual production in first through fourth lactations, 2) difference between first and second lactation yield, and 3) first lactation performance for animals with only one lactation versus those with at least two lactations. Number of cases was determined by number of treatments. Treatments less than 30 days after a previous one were considered the same case. Case was adjusted for length of lactation. Cows leaving the herd for mastitis and not listed as treated were considered to have one case during that lactation. Data were on Holsteins calving between 1986 and 1997 from the NCSU Dairy Educational Unit and two NC Department of Agriculture herds. Calving month was divided into two seasons: summer (months 4-9) and winter (months 1-3, 10-12). First (1483), second (1029), third (654), and fourth (406) lactation cows were used to investigate deviations of predicted and actual yields. Predicted value was sire's PTA + $.5 \times$ mgs's PTA + $.25 \times$ mggs's PTA + 9479 kg (milk) or 346 kg (fat). Difference was predicted yield (milk or fat) minus mature equivalent yield. Model was difference = case + herd*year of calving + season. Case had a highly significant and negative effect on production in the first three lactations, with each case equivalent to a loss of 450 kg of milk and 14 kg of fat in first lactation. For predicting deviation between first and second lactation, 776 animals were used. Change was yield (second lactation) minus yield (first lactation). Model was change = case^{secondlactation} + herd*year of calving^{firstlactation}. Case (second lactation) had a large, negative effect on difference between first and second lactation. First lactation data on animals that only had a first lactation (565) were compared with data on animals that had two or more lactations (772). Animals without a second lactation had lower milk production, fewer days in milk, and more cases in their first lactation than animals with

a second lactation. Overall, mastitis resulted in significant current and future performance losses.

Key Words: Mastitis, Yields, Holsteins

210 Estimates of genetic parameters for milk yield of first lactation Holstein cows. A. P. Márquez*¹, J. H. Herrera², A. Correa¹, F. J. Verdugo¹, H. C. Hernández³, and H. G. González¹, ¹Universidad Autónoma de Baja California, ²Colegio de Postgraduados, ³Universidad Autónoma de Baja California Sur, Mexico.

First lactation records (n=330) for milk yield of Holstein cows, from 42 sires were analyzed by using least squares. The objective was to estimate genetic parameters. Environmental correlation value (c^2) was used as a component of the equation to estimate breeding values for milk yield due to sires. The model included: season of parturition as a fixed effect, sire, sire x season interaction and the residual as random effects. The average milk yield 305d 2x in first lactations cows was $8757.50 \pm 1,401.89$ kg; the projected milk production to mature equivalent $11,012.20 \pm 1,735.62$ kg. The averages for milk yield of first lactation cows grouped by season of parturition were: $9,028 \pm 124.34$, $8,232.90 \pm 1,163.96$ and $8,783 \pm 1,602.42$ kg October to January, February to May and June to September, respectively. Significant differences ($P < .01$) in milk yield were found between cows where parturitions occurred from February to May, but no difference ($P > .05$) was found between cows where parturition occurred from June to September. The average predicted milk difference was 65 ± 130.14 kg. These estimates were different from the reported values in sires summaries. The estimated value of the correlation between milk yield 305d and projected milk yield to mature equivalent was ($r = .93$). The estimated heritability value for milk yield was ($h^2 = .36 \pm 0.33$). The variance component due to sire effect (209,865.28) was highly significant for milk yield.

Key Words: Heritability, Breeding values, First lactation

211 Estimates of genetic parameters and breeding values for milk yield in a Holstein dairy herd at north west of Mexico. A. P. Márquez*¹, J. H. Herrera², G. H. Torres², A. Correa¹, and H.G. González¹, ¹Universidad Autónoma de Baja California, ²Colegio de Postgraduados, Mexico.

An analysis was made of 722 Holstein cows, daughters of 55 sires in 1,077 lactations. Data came from a dairy herd in Mexicali, Baja California, México. Data was analyzed by using MIVQUE. It allowed to estimate the heritability value (h^2) to milk yield. Lactations were classified within cows and sires to estimate through the intraclass correlation among paternal half sibs, the heritability value for milk yield. The average milk yield 8,437 kg 305d suggest a reasonable high productivity by cow. The average values for length of lactation, dry period, open days, parturition interval and number of services per conception were (295.80, 59.17, 127.80, 437.80, and 2.9) respectively. The estimated heritability value for milk yield ($h^2 = 0.28 \pm 0.05$) is similar to the reported values for the same index for this trait. The estimated repeatability value for the same trait was ($R = 0.33 \pm 0.55$). The magnitude of this value suggest a very similar environment in the animals whose the heritability value was estimated. The results on the estimated breeding values can be considered as reasonable values. Although those estimated values were different to reported values of predicted difference for milk yield into sires summaries.

Key Words: Milk yield, Heritability, Repetability

212 Collection, validation, and use of test-day data for genetic evaluations. J.C. Philpot* and G.R. Wiggans, Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.

For the August 2000 implementation of the first phase of a test-day model for US genetic evaluations of yield traits of dairy cattle, test-day data have been collected by the Animal Improvement Programs Laboratory (AIPL) for cows that have calved since 1990. The database includes more than 185 million test-day records from 24 million lactations. About 3.5 million observations are added each month. Test-day information is stored on a cow and herd basis. Cow information includes cow identification, herd code, calving date, days in milk, milking frequency, milk yield, fat and protein percentages, and somatic cell score. Herd information includes information on milk recording, such as sampling frequency,

supervision received, and averaging of milk weights. Data are subjected to extensive validation. Test dates for the cow must match test dates for the herd. Test-day milking characteristics for individual cows are compared with herd milking characteristics. Results of record editing are carefully monitored to allow detection of potential problems with incoming records, such as an unusually high number of records that were replaced, deleted, or rejected. Test-day data are available to industry cooperators at the AIPL web site (<http://aipl.arsusda.gov>). Authorized users can query by cow or herd identification numbers and obtain test-day information. Error records from rejected test-day data also are available by querying on cow, sire, or herd identification numbers. Although test-day data were acquired for most herds, some gaps remain, particularly for the early 1990s. Some cows with lactation data do not have test-day data. The date for using test-day rather than lactation data in the national genetic evaluation system will be determined for each herd and based on the amount of test-day data available for that herd. For Holsteins, test-day records will be used for 42% of 1990 calvings, 78% of 1995 calvings, and >99% of 1999 calvings.

Key Words: Test-day model, Data collection, Data validation

213 Effects of crossbreeding and season of calving on production of milk fat and protein of primiparous dairy cows. K. E. Lesmeister¹, D. W. Kellogg¹, A. H. Brown, Jr.¹, Z. B. Johnson¹, and A. G. Lane², ¹University of Arkansas, Fayetteville, ²Lane Ag Consultants, Stephenville, TX.

Effects of crossbreeding and season on milk fat and milk protein production were analyzed using first lactation records of 1,003 Holstein (H), 60 Brown Swiss X H cows (BSH), and 52 Jersey X H cows (JH). Projected actual 305-d (PA) and mature equivalent 305-d (ME) records were used to develop groups of BSH and JH cows that were contemporaries of H cows calving within the same month or 4-mo period as the BSH or JH crosses, respectively. Effects analyzed were seasonal effect, breed effect, and a season by breed interaction effect. There was a significant seasonal difference in PA kg of fat in the JH group. Significant differences for PA percent fat were observed in both contemporary groups for all effects, except seasonal effect in the BSH group. Significant differences in PA protein yield were observed for seasonal effect in both contemporary groups and for breed effect in the JH contemporary group (JH, 253.4 ± 9.0 kg; H, 285.7 ± 1.7 kg). Seasonal effect, breed effect, and season by breed interaction effect were significant for PA percent protein and ME percent protein in both contemporary groups. The BSH group had significant differences for ME fat yield for seasonal and breed effects (BSH, 391.4 ± 9.4 kg; H, 338.7 ± 3.7 kg). Significant differences were observed in ME percentage of milk fat in the JH group for all effects and in the BSH group for breed effects (BSH, 3.70 ± .07%; H, 3.42 ± .03%). Significant differences were also observed in ME protein yield in both contemporary groups for seasonal and breed effects (BSH, 353.8 ± 8.4 kg; H, 317.2 ± 3.3 kg; JH, 295.7 ± 9.6 kg; H, 321.1 ± 1.8 kg). The data suggest that seasonal variations influenced actual kilograms of fat and protein produced by BSH cows and H cows similarly, but affected JH cows more than H cows. Actual fat and protein percentages were less affected by seasonal fluctuations in crossbreds than in Holsteins.

Key Words: Dairy Cows, Crossbreeding, Seasonal Production

214 Effects of crossbreeding and season of calving on milk production of primiparous dairy cows. K. E. Lesmeister¹, D. W. Kellogg¹, A. H. Brown, Jr.¹, Z. B. Johnson¹, and A. G. Lane², ¹University of Arkansas, Fayetteville, ²Lane Ag Consultants, Stephenville, TX.

Effects of crossbreeding and season on milk production were analyzed using first lactation records of 1,003 Holstein (H), 60 Brown Swiss X H cows (BSH), and 52 Jersey X H (JH) cows of Norwood Dairy Farm near Goldthwaite, TX. Projected actual (PA) 305-d milk and mature equivalent (ME) 305-d milk yields were used to develop groups of BSH and JH that were contemporaries of H cows calving within the same month or 4-mo period as the BSH or JH crosses, respectively. Utilization of net energy for lactation (NE_L) was calculated for a sample of cows that were weighed during lactation. Effects analyzed were breed, season, and breed by season interaction. There was no significant difference in PA milk yield between BSH (7824 ± 232 kg) and H (8137 ± 92 kg) cows; however milk yield corrected for ME was higher (P < .05) for BSH (10,640 ± 276 kg) than H (10,019 ± 109 kg). The H cows produced more (P < .01) than JH cows (8688 ± 55 vs. 7360 ± 284 kg PA milk and 10,131 ± 60 vs. 8735 ± 314 kg ME milk, respectively). There were no differences in either PA or ME milk yield between BSH and H cows

due to season. The JH cows produced less PA milk during summer than H cows and the interaction effect was significant, but ME milk yield was similar for JH and H cows. Based on metabolic body weights of 112, 98, and 106 kg (± 3 kg), the sample of cows used 67.8, 69.4, and 68.1% of NE_L for milk yield for BSH (n = 9), JH (n = 11), and H (n = 12), respectively. The data suggest that while JH cows produce less milk than BSH or H cows during the first lactation, JH cows are as efficient in use of NE_L as the larger cows. If crossbreeding improves longevity, it may be a viable option for breeding dairy cows.

Key Words: Dairy Cows, Crossbreeding, Milk Production

215 Milk production loss associated with mastitis and the efficacy of treatment protocols. E.H. Shim*, D.E. Morin, and R.D. Shanks, University of Illinois, Urbana.

The recovery in milk yield associated with two treatment protocols for mastitis was used to gauge the efficacy of the protocols. Between January 1994 and December 1995, 104,825 daily milk (DM) records on 540 lactations were taken at the University of Illinois Dairy Unit. Clinical mastitis was associated with 2,903 DM records during 127 lactations. Based on examination, each cow with clinical mastitis was assigned a severity score of 1 (least severe) to 3 (most severe) and randomly assigned to one of two treatment groups: N (supportive treatment only) and A (antibiotics in addition to supportive treatment). Extent of antibiotic and supportive treatment varied according to protocols. A random regression test-day model was used to estimate daily milk yield differences between treatment groups (A and N), time of onset of clinical mastitis (= <150 and >150 in milk), and severity at onset of clinical mastitis (1, 2, or 3). All estimated milk yield losses were those losses associated with the period of clinical mastitis. The average milk loss was 3.65 ± .14 kg/day during the infection period. The addition of antibiotics to supportive therapy alone resulted in 2.31 ± .26 kg/day more milk. The loss in daily milk yield was also dependent on the severity score at onset of clinical mastitis. Cows with a severity score of 1 produced .86 ± .22 kg/day more milk than the average of cows with a severity score of 2 or 3. Cows with a severity score of 2 produced 1.80 ± .41 kg/day more than cows with a severity score of 3. Mastitis episodes that occurred during the first 150 days of lactation did not result in significantly more milk yield loss than episodes occurring after 150 days. Based on less severe milk yield losses, the efficacy of antibiotics in addition to supportive therapy was greater than supportive therapy alone.

Key Words: cow, mastitis, antibiotics

216 Effect of adjustment for herd test day on repeatability and heritability of 305-day milk, fat, and protein yields. H.D. Norman*, J.R. Wright, and G.R. Wiggins, Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.

The impact on repeatability (R) and heritability (h²) was examined for adjustment for effects of herd test day prior to the use of the best prediction method to calculate 305-d lactation records from test-day data. The purpose of adjusting for each herd test day is to remove its effect directly before test-day yields are combined to estimate 305-d yield. If herd test-day adjustments account for environmental effects more effectively, the genetic component of lactation records should contribute to higher R and h². Estimates of R and h² were compared with and without adjustment for herd test day. Test-day yields of milk, fat, and protein from US cows that calved after 1989 were analyzed for Ayrshires, Brown Swiss, Guernseys, Jerseys, and Milking Shorthorns; test-day records for Holsteins were limited to cows that calved in California, Pennsylvania, Texas, and Wisconsin. Because R varies with closeness of parity, separate estimates of R were calculated for each parity pair by calculating the regression of yield from the later parity on yield from the earlier parity within herd and calving year. Similar comparisons were made for the impact of herd test-day adjustments on h² by calculating the regression of daughter yield on dam yield within herd, dam calving year, and daughter calving year. Across breeds for all yield traits, R for second parity based on first parity was 0.53 to 0.64 regardless of adjustment for herd test day. For Jerseys and Brown Swiss, R was equal or slightly higher (0.01) after adjustment for herd test day; for Holsteins, R was 0.01 higher for all three yield traits. First-parity h² were equal or higher (≤0.03) for all breeds and yield traits after adjustment for herd test day. Some improvement in accuracy of genetic evaluations will be achieved when lactations are adjusted for effect of herd test day.

Key Words: Test-Day adjustment, Best Prediction, Heritability

217 Effects of inbreeding on reproductive and growth traits, and breeding values in a closed Brown Swiss herd. A. S. Falcao¹, R. M. Filho², C.D.U. Magnabosco^{*3}, and R. Bozzi⁴, ¹Universidade Estadual de Maring, Brasil, ²Universidade Federal do Cear, Fortaleza, Brasil, ³Embrapa Cerrados, Planaltina, Brasil, ⁴UNIFI, Firenze, Italia.

Inbreeding effects on calving interval (CI), birth weight (BW), weaning weight (WW) and on the direct and maternal breeding values for BW were evaluated in a purebred Brown Swiss herd in northeast Brazil. Data were collected from 1946 to 1993. Inbreeding coefficients (F) were estimated according to method of Wright using the MTDFREML package. Breeding values were estimated using a BLUP animal model that included sex, month and year of birth and parity of dam as fixed effects, and direct and maternal inbreeding as covariates. The GLM procedure (SAS Institute, Cary, NC) was used to perform the statistical analyses. The relationship matrix included 1,209 animals and the average and maximum inbreeding were 12.5% and 38.3% respectively. In general, increases in inbreeding levels were followed by reductions on direct breeding value for BW. Of the total variance, direct effects for BW accounted for 47% and maternal effects for 40%. For CI, the effects of sire of dam, parity of dam and year of birth were significant (P<0.01), and the regression coefficient of CI on direct inbreeding was 1.4. For BW, the effects of sire, sex, month, age of dam and linear and quadratic direct inbreeding were significant (P<0.01). The effects of sire and sex were significant for WW (P<0.05). The regression coefficient of WW on maternal inbreeding was -0.51 ± 0.14 kg. These results indicate that direct inbreeding decreased individual breeding values for BW, possibly due to reduced additive genetic variance. However, these levels of inbreeding were not sufficient to affect the genetic merit of the dams.

Key Words: Inbreeding, Breeding values, Brown Swiss

218 Quality of reproductive event data for Dairy Herd Improvement herds in Wisconsin. W. Zhang* and G. E. Shook, University of Wisconsin, Madison.

Accuracy of genetic evaluation for reproductive traits depends on accurate recording of reproductive events. The objective of this study was to develop criteria to measure the within herd quality of reproductive data. Because gestation length (GL) is biologically determined and has low variation, it was selected to judge herd performance in reporting reproductive events. Data from Holstein herds during 1987 to 1999 were provided by AgSource Cooperative. A total of 4,733 herds reported 590,799 parities with at least one breeding date and subsequent calving date; these were defined as complete records (CR). Gestation length was calculated as days from last breeding to calving. Records that ended in abortion or had calculated GL outside the range 265 to 308 d were omitted. The overall mean of GL was 280.4 d. A summary for each herd was computed that included herd average and SD of GL and number and percentage of cows in the herd with useable CR (UCR). The average within herd standard deviation (SD) was 6.2 d. The table below summarizes herds stratified by percentage of herd with UCR (PUCR). Herds with PUCR <40% have relatively high average and SD of GL. These herds appear less consistent in reporting reproductive information. When herds were stratified by average GL, those with >282.0 d had larger within herd SD (7.66 d). Similarly herds with SD >8.0 d had higher mean GL (282.1 d). Herds in these strata may have questionable data quality. Based on these criteria, more than 3,500 herds with nearly 490,000 parities reported breeding dates that appear to be sufficiently consistent with subsequent calving dates.

Herd	Average UCR per herd	Average total records per herds	Number of herds	Average GL	Average SD of GL
<40	39.9	101.5	410	281.01	7.24
41-50	65.3	142.3	1401	280.50	6.25
51-60	88.9	160.4	1316	280.29	6.01
61-70	81.8	126.6	675	280.30	6.17
>71	52.3	66.4	902	280.43	6.11

Key Words: Gestation Length, Reproductive Data Quality, Dairy Cattle

219 Impact of input data quality on national genetic evaluations. H. Jorjani*, Interbull Centre, Uppsala, Sweden.

Individual test-day records of dairy cows go through a number of genetically motivated statistical treatments until they are summarized in a few estimated genetic parameters. Each of these statistical treatments contributes to what is commonly known as input data quality. Unfortunately, the concept of input data quality is not adequately well-defined. The objective of this study was to identify some structural and operational parameters that can contribute to a more precise definition of input data quality. For this purpose sire standard deviations for milk, fat and protein yields estimated in the Interbull Centre for 63 dairy cattle populations from 26 countries and six breeds were used. Apart from country of origin, breed and trait, the data set included information on 14 different parameters that are used in national genetic evaluations. Number of bulls in the progeny testing programs and number of lactations used in the evaluations had a significant effect (p<0.05) on sire standard deviations for all traits in the Holstein and Simmental populations, respectively. Extension of lactation records had a highly significant effect (p<0.001) across countries for all traits. Number of fixed effects included in the genetic evaluation model had a varying significant effect (from p<0.05 to p<0.001) depending on the trait, breed and model of analysis. The national genetic evaluation model had also a highly significant effect (p<0.001). However, length of production and pedigree data, number of lactations, weighting factors for lactations, number of effects used in pre-adjustments, number of random effects in the evaluation model, minimum required reliability for publication of proofs, and percentage of sire-identified records did not have any detectable significant effect. The same was true for days open. It should be emphasized that the data set used in the analyses was quite small and therefore it may have contributed to the inability of detecting significant effects for some of these parameters. One unexpected result was the absence of any significant effect (p>0.05) for breed within countries.

Key Words: Input data quality, national genetic evaluation

220 Comparison of genetic evaluations of culled and surviving cows. T.A. Ferris*¹, H.D. Norman², and G.R. Wiggans², ¹Department of Animal Science, Michigan State University, East Lansing, MI 48824, ²Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.

Nearly 2 million Holstein lactation records from calvings during 1990 through 1997 (a 10% sample of Holstein data) that were acceptable for USDA genetic evaluations were used to determine age and genetic differences in predicted transmitting ability for milk (PTAM) and productive life (PTAPL) between surviving and culled cows. Only records from cows in herds that remained on test long enough to provide those cows with an opportunity to calve again were included. Cows sold for dairy purposes were excluded. Annual mean PTAM and PTAPL by calving year are in the table below. Annual trends were 49 kg for PTAM and 0.09 mo for PTAPL for survivors versus 50 kg for PTAM and 0.10 mo for PTAPL for culls. Mean PTAM for grade cows across years (67 kg for survivors and -10 kg for culls) were higher than corresponding mean PTAM for registered cows (54 and -19 kg). Mean PTAPL for grade cows across years (0.23 mo for survivors and -0.18 mo for culls) were lower than corresponding mean PTAPL for registered cows (.69 and .32 mo). Mean age of cows that left the herd ranged from 65.2 mo for grade cows and 64.8 mo for registered cows during 1990 to 76.8 and 65.1 mo, respectively, during 1997. Trends for PTAM and PTAPL were similar for surviving and cull cows, and surviving cows were genetically superior for yield and longevity. Age of cows that left the herd increased for grade herds over time.

Trait	Group	1990	1991	1992	1993	1994	1995	1996	1997
PTAM (kg)	Survivors	-145	-91	-37	19	78	137	194	246
	Culls	-234	-179	-125	-73	-12	43	105	170
	Difference	89	88	88	92	90	94	89	76
PTAPL (mo)	Survivors	-0.01	0.10	0.20	0.31	0.44	0.56	0.65	0.74
	Culls	-0.44	-0.34	-0.23	-0.12	0.00	0.13	0.24	0.34
	Difference	0.43	0.44	0.43	0.43	0.44	0.43	0.41	0.40

Key Words: Genetic evaluation, Culling, Longevity

221 Growth, luteal activity, and pregnancy rates of three breed types of dairy heifers. A. H. Brown, Jr.*¹, D. W. Kellogg, Z. B. Johnson, R. W. Rorie, W. K. Coblenz, K. M. Lesmeister, and W. R. Jackson, *University of Arkansas, Fayetteville*.

Growth, luteal activity and pregnancy rates were evaluated for three breed types of dairy heifer replacements. Eighty-nine dairy heifers were obtained from the Norwood Dairy Farm near Goldthwaite, Texas and raised as contemporaries at the University of Arkansas Agricultural Experiment Station in Fayetteville. Heifers were born between May 20 and August 6, 1998, and breed types were Holstein (H, n = 35), Jersey x H (JH, n = 30) and Brown Swiss x H (BSH, n = 24). Heifers were developed on pasture with grain supplementation to ensure .9 kg of daily BW gain. Body hip height, chest depth, BW and body condition score (BCS) were obtained. Heifers were considered cycling by 12 mo of age if progesterone concentrations were ≥ 1 ng/ml in either of the two serum samples taken 10 days apart. Heifers were bred by AI on a synchronized estrus starting at about 14 mo of age. Pregnancy status for each heifer was determined ultrasonically after approximately 30 d of gestation. Data were analyzed by least squares ANOVA procedures to determine differences among trait means for the three breed types. Heifer age was included as a covariate in the analysis. The JH were lighter ($P < .05$) than the other two breed types, with BSH and H having similar ($P > .05$) weights. Brown Swiss x Holstein and H were similar for mean hip height ($125 \pm .9$ and $126 \pm .7$ cm, $P > .05$) and both breed types were taller ($P < .05$) than JH ($120 \pm .8$ cm). There were no differences ($P > .05$) between breed types for mean depth of chest and mean BCS at 12 mo of age. The percentages of cyclic heifers were greater ($P < .05$) for JH (90%) than for BSH (75%) or H (47%). Mean pregnancy rates did not differ ($P < .05$) among the three breed types (BSH, 96%, JH, 87%, and H, 77%). These data suggest that the genetic effects of crossbreeding influence early growth and cyclicity at 12 mo of age for dairy heifers.

Key Words: Dairy Cattle, Crossbreeding, Growth

222 Metropolis-Hastings procedures to sample directly from the joint posterior distribution of dispersion parameters. R.A.A. Torres, Jr.* and R. L. Quaas, *Cornell University, Ithaca, NY*.

Gibbs Sampling (GS) has been a popular computing algorithm for posterior estimation of variance components (VC). Block updates have been proposed to reduce the dependency of consecutive samples. The extreme case is the version of GS that samples β 's and u 's from their joint distribution, conditional on the VC. Here, we propose a Metropolis-Hastings (MH) sampling scheme, in order to sample directly from the joint posterior of the VC. It uses the same sparse matrix tools used in the derivative-free REML packages, and samples directly from the joint posterior of the VC without ever sampling a β or a u . Two possible candidate generating functions are used. One borrows the idea from the way the GS procedure works and samples the candidate VC from an Inverted Wishart distribution whose mean is equal to their current value (this is close to what the GS does when little data is available). The degrees of freedom are chosen to balance out acceptance rate and size of each step in this random walk MH scheme (MHR). The other function is a multivariate normal (MVN), which describes the state of the knowledge about the VC's. This is an example of independence chain MH (MHi) and the mean and variance for the MVN can be chosen either based on previous tuning runs of MHR or based on a MVN approximation of the posterior around its mode. The procedures are tested using a simulated data set with 6019 test-day records of 711 cows, with a fifth degree polynomial random lactation curve for each cow and a constant residual variance. Two chains with 25,000 samples were run for the MHR and MHi procedures. The MHi method represented a clear improvement over the MHR method in terms of decay on the autocorrelation. MHi had long runs with no acceptance, showing the existence of highly under-sampled regions. The choice of the MVN distribution might be what caused this, but it was chosen for being easy to simulate and for allowing a flexible description of the covariance.

Key Words: Variance Components, Markov Chain Monte Carlo Methods, Covariance Function

223 Impact of lactation length adjustment procedures on accuracy and heritability of adjusted milk yield in buffaloes. M. S. Khan¹, H. Z. Chaudhry*¹, and S. H. Raza¹, ¹*Faculty of Animal Husbandry, University of Agriculture, Faisalabad, Pakistan*.

Data on 2704 lactations of Nili-Ravi buffaloes were analyzed to compare different procedures to adjust milk yield for lactation length. Differences between predicted and actual yield (bias), standard deviation of bias and heritability under an animal model were the criteria for comparison. Milk yield (\pm standard deviation) averaged 1984 ± 773 kg with lactation length of 267 ± 55 days. Fifty-nine percent of the lactations were shorter than 44 weeks. Lactations were short mostly due to reproductive problems, mastitis or culling because of poor production, old age and repeat breeding. However, in most cases animals with shorter lactations dried gradually. Lactation curves of first and later parity buffaloes were also different. Milk yield adjusted to 308 days increased from first parity (1731.8 ± 78.86 kg) to third parity (1919.6 ± 64.56 kg) but declined gradually thereafter. Yield predicted from a linear regression equation (having lactation length as the only predictor) or from the last record-day information was higher as compared to actual milk yield due to extrapolation to a higher base. Linear regression procedure tended to overestimate the yield in the later part of the lactation curve. The standard deviation of bias decreased and correlation between actual and predicted lactation milk yield improved with inclusion of average daily milk yield as a predictor along with the last record-day milk yield. Heritability estimates of milk yield improved as data set was restricted to include more completed lactations (≥ 180 days). Heritability of unadjusted lactation milk yield was 9.1% while for 308-day lactation milk yield (adjusted by using last record-day information and average daily milk yield), it varied from 10.7 to 12.0%, depending on the model. Information on last recorded milk yield along with average daily milk yield of the recorded lactation period are suggested to be used as a basis for adjusting milk yield data in Nili-Ravi buffaloes.

Key Words: Buffalo, Pakistan, Lactation length, Adjusted Milk yield, Heritability

224 SIMBULL2: An instructional simulator for dairy cattle breeding and management. G. E. Shook*, E. D. Hailman, and M. R. Dentine, *University of Wisconsin, Madison*.

SIMBULL2 places students in the role of herd manager and provides experience in making decisions that create genetic improvement. The software runs on a personal computer with the WindowsTM operating system. Students make breeding, culling, and mating decisions for a simulated herd of lactating cows and herd replacements. The simulator manages a bull stud from which the student selects sires for herd replacements. Each run of the program represents one year of herd operation. The simulator enables students to practice and evaluate several years of breeding decisions within the scope of a few weeks. The program displays lactation performance records and genetic evaluations for six traits similar to information available in the industry. Also simulated are an appearance trait and a genetic lethal condition with single locus genotypes. An inbreeding coefficient is displayed for each animal and the performance model includes inbreeding depression. Performance records and breeding values are generated stochastically so each herd and bull stud is unique. The software is designed for flexibility in instructional goals and students level of experience. Level 1 provides for decisions related to conventional AI and generates performance reports and genetic evaluations for a standard complement of traits: yields of milk fat, and protein, final type score, mammary composite score, and calving difficulty. Level 2 allows user choice of performance traits, use of multiple ovulation and embryo transfer, progeny testing and selling bulls produced by the herd, and user defined selection indexes. An economic option generates semen costs and an annual operating statement that tracks revenues from sale of milk and animals as well as costs for breeding, feeding, and housing. Students confront problems similar to those encountered by commercial producers. These problems stimulate a higher level of thinking and analysis and create unanticipated learning opportunities in an active learning mode.

Key Words: Dairy Cattle Breeding, Simulation, Instruction

225 Preconditioned conjugate gradient method by iteration on data for solving mixed model equations. S. Tsuruta^{*1}, I. Misztal¹, and I. Strandén², ¹University of Georgia, Athens, GA, ²Agriculture Research Centre, Jokioinen, Finland.

Preconditioned conjugate gradient method (PCG) using iteration on data was compared with the successive-overrelaxation algorithm (SOR) in terms of convergence when solving mixed model equations. PCG with a diagonal preconditioner was implemented using single- and double-precision vectors. Sixteen different models were used in the comparison, with data on beef, dairy, and swine, and with data size ranging from small examples to national data sets. The models included single and multiple traits as well as maternal effects and random regressions, and having low and high genetic correlations. Convergence was based on relative differences between left- and right-hand sides. PCG implemented with double precision converged for all models with up to 30 times fewer rounds of iteration than SOR. PCG implemented in single precision did not converge for large models. Differences in convergence rate between single- and double-precision SOR were small. PCG with the iteration on data is very easy to implement for a large class of models while such an implementation is more difficult and model-specific for SOR. Also, SOR requires an adjustment of an iteration parameter while the PCG algorithm does not. For reliable implementation, PCG requires double precision storage of 4 out of 5 variables/equation. Only one single-precision variable/equation is required by SOR although efficient implementations may use more storage. The PCG algorithm with the diagonal preconditioner by iteration on data appears to be the method of choice for solving large mixed model equations when sufficient memory is available.

Key Words: Preconditioned conjugate gradient, Iteration on data, Convergence rate

226 Application of hierarchical models to analysis of test day yields. J. Jamrozik* and L.R. Schaeffer, University of Guelph, Ontario, Canada.

First lactation test day milk yield records of Canadian Holstein cows from Ontario and Quebec were analysed by three Bayesian hierarchical models. Wilmlink's function for the lactation curve for each cow was included in the first stage for all three models. Herd-test date (HTD) subclasses were included in the first stage for models 1 and 2, but not 3. Residual effects of the first stage model were uncorrelated with constant variances within each of 29 DIM intervals. The observations for the second stage multiple trait model were the lactation curve parameters per cow. The second stage model included animal additive genetic and region-age-season effects in all three models, and herd-year-season (HYS) effects in models 2 and 3 only. Genetic parameters for lactation curve coefficients, daily yields, 305d yield, and persistency (the difference in yields between day 60 and 280) were estimated as posterior means of samples generated by the Gibbs sampling method. Models with HTD effects gave smaller estimates of residual variances over all 29 DIM intervals. Models with HYS in the second stage reduced the estimates of genetic variances for daily milk yields and their heritabilities, and gave higher genetic correlations between yields that were far apart in DIM. Heritability of persistency was 0.23 without HYS in the second stage and 0.16 with HYS effect. Inclusion of HYS effects gave estimates of genetic parameters that were closer to estimates from multiple trait models. Hierarchical models with linear trajectories are equivalent to random regression models.

Key Words: Test day yields, Hierarchical models, Genetic parameters

227 Modeling accuracy of final score observations at different ages. L. Klei^{*1}, T.J. Lawlor¹, I. Misztal², and S. Tsuruta², ¹Holstein Association USA, Inc., Brattleboro, VT., ²University of Georgia, Athens.

It is a general belief among dairy farmers that conformation scores obtained on young cows are not as valuable in assessing the genetic potential of a sire as those obtained on older daughters. In the current genetic evaluation, age differences are accounted for through a fixed effect. This takes into account differences in the average effect of each age but does not address potential differences in the accuracy of scores or differences in components of variance due to age. The objective of this study was to investigate modeling solutions to differences in accuracy associated with age at classification. Final score observations on cows born since

1984 were obtained from Holstein Association USA. Cows had a first score between 25 and 36 months of age and a second score between 42 and 54 months of age. Data were categorized into four subsets. All subsets contained first scores on all animals, but only animals within each age subset (25-27, 28-30, 31-33, 34-36 months of age) were allowed to have a second score. Minimum contemporary group size was 10 and 5 for first and second score, respectively. Contemporary groups had at least one animal with a second score. For computational reasons one out every five herds was used. Number of animals with records were 24,005, 50,379, 53,492, and 43,292, respectively. Number of second scores were 3082, 16,073, 17,880, and 10,281, respectively. Data were analyzed with a model containing fixed effects for herd-year-classifier, age at classification, and stage of lactation at classification. Random effects were animal, permanent environment, herd by sire interaction, and residual. Variance components were estimated using average information REML. Phenotypic variance estimates ranged from 11.33 to 11.90, heritability from .24 to .25, permanent environment ratio from .33 to .44, and herd by sire interaction from .02 to .03. Repeatability was .61, .67, .70, and .71 for the four age groups, respectively. This shows that first scores given at a later age are a better indicator of an animal's score at maturity than those given at a young age. Results also show that the change in repeatability is fully accounted for by a change in permanent environment while the other components of variance remain constant over time. Other approaches of modeling this problem model will be discussed.

Key Words: Modeling, Precision, Conformation

228 Approximation of reliabilities for multiple-trait model with maternal effects. T. Strabel*, I. Misztal, and J. K. Bertrand, University of Georgia, Athens.

The purpose of this study was to design an inexpensive algorithm for computing accuracies of breeding values in multiple-trait models used for beef evaluation. Single trait accuracies were approximated by combining the effective number of records with pedigree information for each set of animal and parents separately. Supported models included additive and permanent environmental but not maternal effects. To support maternal effects, approximations were obtained separately for the direct and the maternal effect. For the direct effect, the maternal and permanent environmental variances were assigned to the residual. For the maternal effect, variance of the direct effect was assigned to the residual. Components of single-trait accuracies were used to create a multiple-trait mixed-model coefficient matrix for each animal, and approximate accuracy was obtained by inversion. Data included 10,550 birth weights (BW), 11,819 weaning weights (WW) and 3,617 postweaning gains (GA). Accuracies were computed by inversion of the complete mixed-model coefficient matrix and by multiple-trait approximations. Some accuracies obtained by inversion were negative because inbreeding was ignored in creation of the inverse of the relationship matrix. The correlations between accuracies obtained by inversion and by approximation for the direct effect were .78 for BW, .90 for WW and .92 for GA. The correlations for maternal effects for BW and WW were .95 and -.97, respectively. When the formula used to calculate the effective number of daughters ignored the distribution of sires in contemporary groups, the approximation greatly overestimated accuracy of sires in single-sire contemporary groups. When the formula was revised to ignore such groups, the approximation became better for high accuracy but worse for low accuracy animals. The importance of the formula diminishes in larger data sets where contemporary groups are generally larger. The proposed approximation is applicable to national cattle evaluations.

Key Words: accuracy of evaluation, maternal effect, beef cattle

229 Bayesian variable selection for describing growth data using a random regression model. F. E. Grignola* and J. P. Steibel, Facultad de Agronomia, Universidad de Buenos Aires, Argentina.

Growth data can be considered as consecutive measurements on one variable for the same individual, or group of individuals, over a period of time. The multiple linear regression model can be used to approximate almost any function or shape, and many methods are available for selecting an appropriate subset of regressors. Random regression models fitting a linear function of a set of covariates have been proposed for genetic evaluation purposes in many species. However, how to choose the most suitable function, in terms of the number of covariates to be included, still remains unclear. In this study, a random

regression animal model containing polynomials with fixed and random regression coefficients is used to describe body weight-age relationships in beef cattle. A Bayesian method for subset selection of promising regressors for the systematic effects using the Gibbs sampler is implemented. The method consists of including, in the regression models, vectors containing indicator variables for each regressor and then computing their posterior distribution. Therefore, the submodels associated with vectors that have high posterior probability can be selected. Of all possible $2^{\text{predictors}}$ submodels for each contemporary group, only a few showed high posterior probability, and their probabilities were affected by the priors chosen. For any linear function of covariates proposed to model growth data, the method provides an alternative for subset selecting the covariates to be considered.

Key Words: Random regression, Variable selection, Gibbs sampler

230 Covariance estimation with Method-R. T. Druet^{*1,4}, I. Misztal², M. Duangjinda², A. Reverter³, and N. Gengler^{1,4}, ¹*National Fund for Scientific Research, Brussels, Belgium*, ²*Department of Animal and Dairy Science, University of Georgia, Athens*, ³*Animal Genetics and Breeding Unit, University of New England, Armidale, Australia*, ⁴*Animal Science Unit, Gembloux Agricultural University, Gembloux.*

The objective of the study was to develop algorithms based on Method-R that allow estimation of (co)variance components with large data sets for complex single trait models, e.g., with correlated additive animal effects and/or with dominance effects. Theoretical Method-R formulas were developed for simplified single and bi-variate models. In single trait, the curve of the regression of Method-R was continuous and monotonic, as is described in the literature, and its slope depended on the amount of information on one animal. The curve was flatter as the number of records per animal increased possibly indicating numerical problems with the sire model. For covariance, the curve of the regression was not always monotonic and it had a discontinuity; a regression factor of 1 still corresponded to the correct covariance. Similar curves were observed in analyses of simulated data sets. Due to the observed discontinuity, algorithms implementing Method-R that require continuous regression curve would not work in models with covariances. An alternative algorithm was based on a transformation matrix obtained by multiplying a matrix of numerators with the inverse of a matrix of denominators of the regression factors. This algorithm always converged in models with covariances, but was slow, requiring as many as 1000 rounds to converge. Convergence, faster by 3-10 times, was achieved by applying over-relaxation. Analyses of several simulated and real data sets by Method-R showed that sampling variance of (co)variance estimates with Method-R was higher for covariances or dominance effects than for additive effects. Therefore, larger number of samples is necessary for more complex models to obtain reliable estimates by Method-R.

Key Words: Method-R, covariance, estimation

231 Genetic variation of lactation curves in dairy sheep: Wood's model versus a quadratic function. Y. M. Chang^{*1}, R. Rekaya², D. Gianola¹, and D. L. Thomas¹, ¹*Department of Animal Sciences, University of Wisconsin, Madison*, ²*Department of Dairy Science, University of Wisconsin, Madison.*

Daily milk yield records (1752) of 451 first-lactation ewes in 4 flocks from Nebraska and Wisconsin were analyzed. Most ewes did not have test-day records prior to day 30, and milk yield was recorded more frequently in the second half of lactation. Objectives were to investigate genetic variation of features of lactation curves using a quadratic function (Q), and to compare this with non-linear Woods function (W). A 3-stage Bayesian hierarchical model was used. At stage 1, the function $y = a + bt + ct^2 + e$ represented within-ewe variation. Stage 2 model described variation in a , b and c between ewes. It had a linear structure with flock-year, age at lambing, type of lambing, length of suckling period and percentage of East Friesian origin genes as fixed effects, and additive genetic effects as random. Stage 3 had prior distributions for all parameters. A chain of 70,000 iterations (burn-in=12,000) was generated using Gibbs sampling. Posterior means of the residual variance were 0.0234 kg² for Q and 0.042 kg² for W. Heritabilities of a , b and c were 0.23, 0.15 and 0.17, respectively. Genetic correlations between parameters in Q ranged between -0.51 and -0.36. Q had an R²=0.92, higher than the 0.74 found for W. The Bayes factor for Q relative to W was 11.64 in a log scale. Using 3 residual standard deviations as cut-off,

the percentages of outliers were 0.2% and 0.4% with the Q and W models, respectively. Both models fitted well but Q failed to predict total milk yield accurately. Model W is more appealing than Q, especially because its parameters have a mechanistic interpretation.

Key Words: Lactation curves, Wood's function, quadratic function

232 Methodology to account for the effect of degree of non-linearity in breeding objectives on selection criteria. G.E. Vander Voort^{*} and G. Jansen, *University of Guelph, Canada.*

In animal breeding, when profit is a non-linear function of the traits in the breeding objective, a linear approximation to this function is usually made at the current population means, at the end of the planning horizon or in each generation within the planning horizon, depending on the goal. A linear selection index is used to select for this linearized goal. An optimal control method to obtain linear selection indexes for multiple stage objectives, based on a non-linear profit function has been developed. Numerical optimal control solutions can be difficult to obtain due to the complexity and degree of non-linearity of the model. To study these difficulties, the optimal control method was transformed into a recursive optimization problem. At each selection stage Adomian's decomposition method was used to derive series expansions of optimal selection index weights. These series are generalized Taylor series expansion about the base function. Numerical procedures to derive optimum indexes are outlined. The methodology was validated by calculating selection index correlations with Strategy D for egg weight and rate of lay example of Dekkers et al. (*Animal Science*, 61:165-175). Average index correlation increased from 0.92 to 0.95 as series order was increased from 3 to 5. Potential use of series order and size to quantified degree of non-linearity are examined.

Key Words: degree of non-linearity, optimal control

233 Structuring the residual covariance matrix in the analysis of longitudinal binary data. R. Rekaya^{*1}, K. A. Weigel¹, and D. Gianola¹, ¹*Department of Dairy Science, University of Wisconsin, Madison.*

Longitudinal binary responses measured repeatedly over time on the same individual tend to be correlated. For example, mastitis infection status of a cow at a given stage of lactation may depend on clinical episodes in preceding stages. Clinical mastitis data (3341 binary test-day records) from 329 first-lactation Holsteins were used to investigate 3 structures of the residual covariance matrix in a longitudinal Bayesian threshold model. Results were compared with those from a multivariate analysis for binary responses in four intervals during lactation. In structure 1, liabilities to mastitis were conditionally (given fixed effects and breeding values) independent. In structure 2, a serial dependence pattern was fitted; the correlation between liability at times i and j was: $\rho^{|t_i - t_j|}$. In structure 3, a constant correlation between periods was assumed. The multivariate analysis showed a decreasing pattern in the residual correlation as the time between intervals increased. Correlations were 0.29 between adjacent intervals and 0.07 between intervals 1 and 4. In the constant correlation structure (3), the posterior mean of ρ was 0.11. Structure 2 gave a pattern similar to that in the multivariate model, but with a single parameter, as opposed to 6 in the latter. In Structure 2 the posterior mean of ρ was 0.22, and the correlation was 0.22 for adjacent test days, 0.05 when the interval between test days was 60 d, approaching 0 for longer intervals. Bayes factors supported Structure 2 for the residual covariance matrix, relative to the alternative parameterizations of ρ .

Key Words: longitudinal data, binary, residual covariance

234 Methods for attenuating bias of variance component estimates in threshold models when herds are small. R. Rekaya^{*1}, K. A. Weigel¹, D. Gianola¹, B. Heringstad², and G. Klemetsdal², ¹*Department of Dairy Science, University of Wisconsin, Madison*, ²*Department of Animal Science, Agricultural University of Norway, Ås, Norway.*

With binary response data and low incidence rates, observations for some levels of contemporary groups, such as herds (β), can be all "successes" or "failures" (1 or 0). This creates the "extreme category problem" (ECP): in likelihood or Bayesian settings (even with proper priors

for β), estimates of variance components are biased. ECP causes difficulties in countries such as Norway, where herds are small, and where selection programs emphasize health and fertility traits, these being categorical. The problem was studied with clinical mastitis records on 13,070 first-lactation daughters of 250 sires in 1868 Norwegian cattle herds. About 32% of herds had no cases of clinical mastitis. Data were analyzed with a threshold model with proper priors for all parameters, leading to a suspicious heritability of 0.18. A simulation using the same incidence structure was conducted. Three techniques for dealing with the ECP were investigated: 1) fuzzy classification of observations within herds according to some membership function. 2) Hierarchical prior for b with unknown mean and variance. 3) Grouping observations from ECP herds with those from low mastitis incidence herds. Technique 2 had the least bias. With the actual data, the posterior mean of heritability of liability to mastitis dropped from 0.18 to 0.07 using technique 2.

Key Words: binary data, variance components, bias

235 Genetic parameters and response to selection in proportional hazard models. M.H. Yazdi*¹, P. Visscher¹, V. Ducrocq², and R. Thompson³, ¹*IERM, University of Edinburgh, UK*, ²*Institut National de la Recherche, Agronomique, Jous-en-Josas, France*, ³*Institute of Arable Crops Research, Harpenden, Hertfordshire, UK*.

Three methods of estimating genetic parameters and response to selection were examined using Weibull proportional hazard models. A new and simple equation for the estimation of heritability of survival time was proposed which does not depend on the Weibull parameters. Theoretical derivations for the heritability and reliability of sire proofs were validated using simulation studies with balanced sire designs. Simulated continuous and discretised data were analysed using (i) a Weibull frailty model, (ii) a linear model on binary observations, and (iii) a proportional hazards model for discrete data. Observed reliabilities were estimated from simulated repeated progeny groups. The expected reliability was calculated using the proposed formula for estimation of heritability. There was very good agreement between observed and expected reliabilities. The estimates of reliabilities from the Weibull model, discrete hazards model and from the linear analysis on binary data were related using simple transformations. For the linear model (binary data analysis) the genetic variation among the sires increased with an increased proportion of uncensored progeny per sire, reaching at maximum at the average proportion of 0.7. The observed and expected responses to selection from different combinations of sire variances and Weibull parameters were very similar. The expected response to selection of sires ranged between 3 to 8 months, depending on the shape of the survival curve and selection intensity.

Key Words: Survival analysis, Genetic parameters, Selection response

236 Beef genetic evaluation programs for carcass traits: current situation and future possibilities. J. K. Bertrand*¹, D. W. Moser², and W. O. Herring³, ¹*University of Georgia, Athens*, ²*Kansas State University, Manhattan*, ³*University of Missouri, Columbia*.

The implementation of grid pricing systems in the U.S. beef industry, where the value of carcasses is based on quality and red meat yield, has put increased emphasis on the development of genetic values to enhance selection for carcass traits. Five U.S. breed associations provide sire EPD for carcass traits based on carcass information from finished steer and heifer progeny. However, the amount of carcass data for most breeds is small compared to other traits such as birth weight, weaning weight, yearling weight, scrotal circumference and calving ease due to the time consuming nature, cost and difficulty of gathering useful carcass information on finished steers and heifers. Ultrasound technology has been explored as a vehicle for the seedstock industry to collect large amounts of data at a reasonable cost, with the potential result that more animals would have genetic values for carcass traits than are currently available. Two U.S. breed associations use yearling seedstock ultrasound measures to predict EPD. Genetic correlations between carcass measures from slaughter animals and yearling ultrasound measures from seedstock cattle were estimated using a Brangus field data set containing 2036 steer and heifer carcass measures and 3583 bull and heifer ultrasound measures. The genetic correlation estimates between yearling seedstock and finished cattle for ribeye and external fat thickness measures were .89

and .69, respectively. The genetic correlation between yearling seedstock measures of percent intramuscular fat with marbling scores in finished cattle was estimated at .70. The results of this study indicated that ultrasound measures from breeding animals can be used to predict genetic values for carcass traits. However, more research is needed to better quantify the genetic relationships between slaughter and live animal ultrasound measures of carcass traits across steers, bulls and heifers of various breeds to develop models that use any combination of carcass and ultrasound information available for the prediction of carcass trait genetic values. Research is also needed for the development of genetic values for tenderness and edible retail product coupled with multi-trait selection tools that allow producers to genetically identify animals that are profitable in grid pricing systems.

Key Words: Genetic Values, Carcass Traits

237 Terminal sire value (TSV): a selection index targeted to improve growth and carcass traits. N. Caron* and R.A. Kemp, *Lethbridge Research Centre, Agriculture & Agri-Food Canada*.

A selection index was developed to compare and select sires for production of market calves. A total of six different selection objectives were compared and each included five economically important traits from birth to slaughter: birth weight (BW), weaning gain (WG), post-weaning gain (PWG), marbling score (MARB) and lean yield (LY). Relative economic values (REV) were based on a review of recent studies. The selection objective chosen as most preferable had REV of 1, 1.5, 1.5, 2 and 3 for BW, WG, PWG, MARB and LY, respectively. The chosen objective was tested for sensitivity to variation in genetic parameters and relative economic values by independently varying each of them by 50% for each trait. For all traits, selection efficiency was higher than 95% with the exception of LY. Selection based on this objective will result in higher WG, PWG, MARB and LY but lower BW. On average, 6.9% of the economic gain will be from BW, 22.7% from growth traits (WG and PWG) and 70.4% from carcass traits (LY and MARB). A selection index, known as the Terminal Sire Value (TSV), has been developed for use in the Conception to Consumer program of the Canadian Charolais Association. The TSV uses EPD of the selection objective traits and is calculated as follows: $TSV = -8.17*EPD_{BW} + 2.63*EPD_{WG} + 3.11*EPD_{PWG} + 86.21*EPD_{LY} + 293.26*EPD_{MARB}$. The TSV is expressed such that the overall mean and standard deviation are 100 and 25, respectively.

Key Words: Beef Cattle, Selection index, Carcass traits

238 Genetic correlations between yearling bull ultrasound measurements and finished steer carcass measurements. C.J.B. Devitt* and J.W. Wilton, *University of Guelph, Ontario, Canada*.

The objective of this study was to determine the genetic relationship between real-time ultrasound measurements on yearling bulls and actual carcass measurements on finished steers. Beef Improvement Ontario provided ultrasound measurements on 5654 purebred yearling bulls of 11 breeds measured at the end of Ontario's 112-day Bull Evaluation Program between 1995 and 1999. All bulls had ultrasound measurements of ribeye area (BREA), backfat thickness (BBFAT), as well as average daily gain (BADG). Ultrasound measured intramuscular fat percent (BIMF) was available on 3450 bulls. Actual carcass measurements were obtained from 843 crossbred steers raised between 1988 and 1998 in the University of Guelph's beef research herd. All steers had measurements of hot carcass weight (SHCW), ribeye area (SREA), backfat thickness (SBFAT), marbling score (SMAR), as well as average daily feedlot gain (SADG). Bulls were represented by 1535 sires averaging 3.7 bulls per sire and steers by 124 sires averaging 6.7 steers per sire. There were 20 sires with both bull and steer progeny, averaging 8.1 bulls, and 12.5 steers per sire. Genetic parameters for all traits were estimated simultaneously using a multiple trait animal model, which considered all genetic relationships between animals. Fixed effects for each trait were breed, management group, and age in days within breed as a covariate. Random effects were individual additive genetic animal effect and residual error. Heritability estimates for all traits were moderate to high. Additive genetic correlations between BREA and SREA, BBFAT and SBFAT, BIMF and SMAR, and BADG and SADG were .66, .80, .88 and .72, respectively. These strong, positive genetic correlation estimates between

bull ultrasound measurements and corresponding steer carcass measurements suggest that genetic improvement for steer carcass traits can be achieved by using yearling bull ultrasound measurements as selection criteria.

Key Words: Beef cattle, Genetic parameters, Ultrasound

239 Associations among ultrasound measures of carcass yield from bulls and heifers and carcass traits of steers. D.H. Crews, Jr., C. Gallivan, P.K. Charagu, and R.A. Kemp*, AAFC Research Centre, Lethbridge, Alberta.

Real time ultrasound (U) measures of ribeye area (R) and fat thickness (F) were taken at 12 and 14 months of age on composite bulls (B, n = 404) and heifers (H, n = 514). Carcass (C) R and F were measured on related steers (n = 235). Two (R and F) five-trait animal models, including traits expressed by B and H at 12 and 14 months of age and carcass traits separately, were used to estimate genetic parameters. Heritability estimates were between .64 and .68 for all ultrasonic measures of R. Heritability estimates were .32 for BUF12, .22 for BUF14, .56 for HUF12 and .55 for HUF14. Estimated genetic correlations between 12- and 14-month UR and UF within sex were above .88. The genetic correlation estimate between BUR12 and HUR12 was .67 and between BUF12 and HUF12 was .61. Estimates were similar at 14 months of age. Heritability estimates for CR (.58) and CF (.43) were similar to literature averages. Estimated genetic correlations of HUF12 with CF and HUR12 with CR were .73 and .71, and at 14 months, were .82 and .81, respectively. Estimated genetic correlations of BUF14 with CF, BUR14 with CR and BUR12 with CR were .38, .40 and .30, respectively. However, the estimated genetic correlation between BUF12 and CF was .07. These results indicate that the choice of age of measurement between yearling and 14 months may have little effect on ultrasound trait breeding value prediction. However, ultrasound measures on bulls and heifers, even at similar ages, may be considered different traits for genetic evaluation. Also, prediction of carcass merit breeding values should incorporate ultrasound and carcass data as separate but correlated traits. Genetic evaluation of carcass merit may be enhanced by including ultrasound data from replacement bulls and heifers and carcass data on siblings or progeny in a multi-trait model for each carcass trait of interest.

Key Words: beef carcass merit, ultrasound, genetic parameters

240 Carcass expected progeny differences using real-time ultrasound measures from developing Angus heifers. D. E. Wilson*, G. H. Rouse, C. L. Hays, and A. Hassen, Iowa State University, Ames.

The objectives of this research were to determine genetic parameter estimates for real-time ultrasound (RTU) measured composition traits on developing Angus heifers and to compare sire expected progeny differences (EPD) based upon RTU measured traits to those based upon carcass measured traits of steer progeny. The RTU measures in this study were from 8,630 developing heifers. The heifers came from 402 contemporary groups as defined by herd and scan date. There were 851 sires represented in the data. RTU images were collected by technicians participating in a two-year research project at Iowa State University (ISU) and funded by the American Angus Association (AAA). ISU image-interpretation technicians made all RTU measurements at the ISU centralized ultrasound processing laboratory from images received from field RTU technicians. The measures included rump fat thickness (RFAT), 12-13th rib fat thickness (FAT), ribeye area (REA), and percentage intramuscular fat (%IMF). Measures were adjusted to a 390-d age end point. Genetic parameter estimates were made using restricted maximum likelihood procedures. The genetic prediction model was a multiple-trait sire model with sire and maternal grandsire additive genetic relationships. Carcass EPD used for comparison came from the Spring 2000 AAA Sire Evaluation Report. The h^2 estimates for RFAT, FAT, REA and %IMF were .56, .48, .40 and .42, respectively. Genetic correlation estimates for RFAT-FAT, FAT-%IMF, REA-%IMF and REA-FAT were .74, .09, -.04, and .23, respectively. Of the 851 sires with RTU-based EPD, 309 sires also had carcass-based EPD. Comparisons were made between EPD from the two sources of data using sire rank correlations. For RTU-EPD and carcass-EPD accuracy levels of .85 and higher, the rank correlations were .69, .76, and .72 for Marbling Score-%IMF, REA, and 12-13th rib fat thickness, respectively. These results indicate that breeders could use EPD based upon RTU measures

from developing Angus heifers to predict the same genetic differences observed from steer progeny carcass measures.

Key Words: Beef Cattle, Composition, Ultrasound

241 Breed comparisons and genetic evaluation of carcass merit in *Bos indicus* x *Bos taurus* breed types in Australia. A. Reverter¹ and S. Newman*², ¹Animal Genetics and Breeding Unit, University of New England, ²CRC for Cattle and Beef Quality, CSIRO Tropical Agriculture, Australia.

Yield and quality data on 6789 purebred and 966 crossbred cattle were analyzed to perform breed comparisons and to estimate genetic correlations among purebred and crossbred performance (r_{PC}). Crossbred calves were produced using 9 Angus, 8 Hereford, 7 Shorthorn, 14 Belmont Red and 8 Santa Gertrudis sires bred to Brahman dams. These same sires produced progeny in the purebred data set. Purebred Brahman calves reared in the same environment as the crossbred individuals were also available. Cattle were managed under two finishing regimes (pasture and feedlot) to representative market weights of 400 (domestic), 520 (Korean), and 600 kg (Japanese). Care was taken to minimize pre-slaughter stress and all carcasses were electrically stimulated. Carcass measures included hot carcass weight (CWT, kg), retail beef yield (RBY, %), NIR-measured intramuscular fat (IMF, %), rump fat depth (P8, mm) and shear force (SF, kg) at the *l. dorsi* muscle. Breed rankings were based on least-squares means and the mean EBV of mixed model solutions estimated as deviations from their respective contemporary group (CG) means where CG did not include breed. Positive heterosis effects (1% to 19%) were estimated for CWT. Heterosis for RBY was negligible while heterosis for IMF and SF ranged from -18% to -1%. Crossbred steers and heifers out of Angus sires produced the heaviest and fattest carcasses with the smallest RBY and SF. In contrast, crossbred progeny out of Belmont Red sires expressed the lightest CWT with the highest RBY but an average performance in the remaining traits. Crossbred data yielded higher heritability estimates for all traits except RBY. Estimates of r_{PC} were .74, .78, .92, .59, and -.46 for CWT, RBY, IMF, P8, and SF, respectively. The negative correlation found for SF might point to overdominant genes for tenderness being recessive in tropically adapted breeds. Commercial breeders selecting sires for crossbreeding programs based on EBV developed from purebred analyses might encounter some re-ranking of sire's performance.

Key Words: Cattle, Crossbreeding, Genetic Evaluation

242 Effect of breed on carcass traits and fatty acid composition in longissimus muscle of finishing steers. L. F. Laborde*, I. B. Mandell, J. J. Tosh, J. W. Wilton, and J. G. Buchanan-Smith, University of Guelph, Ontario, Canada.

One hundred and thirty six Simmental- or Angus-sired, crossbred steers were used to evaluate breed differences in carcass traits and fatty acid composition of total lipids and phospholipids from longissimus muscle. A multiple regression approach was applied to crossbreeding data to estimate genetic differences between Simmental (SM) and Red Angus (RA) at the same level of backfat finish (10-mm grade fat). SM needed more ($P < .001$) days on feed ($+71.0 \pm 18.9$ d) to reach the backfat endpoint, with heavier ($P < .001$) slaughter weights ($+154.1 \pm 35.6$ kg) and hot carcass weights ($+111.4 \pm 22.9$ kg), larger ($P = .002$) longissimus muscle area ($+19.4 \pm 6.2$ cm²), and increased ($P = .023$) lean yield ($+4.1 \pm 1.8$ %) when compared to RA. Breed did not affect ($P = .860$) subjective marbling score. For total lipids, SM had greater ($P < .01$) concentrations of myristoleic ($+28 \pm .10$ %), palmitoleic ($+87 \pm .29$ %), and vaccenic ($+29 \pm .09$ %) acids, and a larger ($P = .022$) omega-6 ($\omega 6$) to omega-3 ($\omega 3$) polyunsaturated fatty acid (PUFA) ratio ($+88 \pm .38$) than RA. In contrast, SM had lower ($P < .05$) concentrations of margaric acid ($-.31 \pm .12$ %), eicosapentaenoic acid ($-.08 \pm .03$ %), and total $\omega 3$ PUFA ($-.29 \pm .15$ %) than RA. Activity of Δ^9 -desaturase enzyme in the conversion of palmitic acid to palmitoleic acid was greater ($P = .001$) in SM ($+2.93 \pm .86$) as compared to RA. Conjugated linoleic acid (CLA) concentration did not differ ($P = .864$) between breeds. For phospholipids, SM had lower ($P < .05$) amounts of eicosapentaenoic acid ($-.55 \pm .25$ %), docosahexaenoic acid ($-.19 \pm .09$ %), and $\omega 3$ PUFA ($-1.23 \pm .58$ %), with a greater ($P = .017$) $\omega 6:\omega 3$ ratio ($+1.40 \pm .58$) as compared to RA. Although breed differences in fatty acid composition were present, implications on human health need to be demonstrated.

Key Words: Beef Cattle, Breeds, Fatty Acids

243 Comparison of Warner-Bratzler shears of F₁ *Bos indicus* × British steers produced by one Nellore and 15 Brahman Bulls. D. G. Riley*, L. B. Hager, J. O. Sanders, R. K. Miller, and D. K. Lunt, *Texas A&M University, College Station.*

Tenderness measures of 251 F₁ steers sired by one Nellore and 15 Brahman bulls and out of Hereford and Angus cows were evaluated. Calves were born from 1994 through 1998 at the Texas A&M University Research Center at McGregor, Texas. They were weaned at about 200 d of age, fed from about November through the end of May of the following year and slaughtered at about 13 mo of age. Carcasses were electrically stimulated and strip loins were stored at 1° C for aging periods. The most anterior steak from the left strip loin of each carcass was assigned to d 14 and steaks were randomized to the remaining aging periods, except that steaks were randomly assigned to all aging periods for carcasses of 1997 born steers. Warner-Bratzler shears (kg) were measured on six cores from steaks from each steer after 0, 7, 14, 21, 28 and 35 d of aging. Average shear force (SF) was analyzed by mixed model procedures with yr-dam breed combination and aging interval as fixed effects. Sire and calf within sire were included as random effects. Two contrasts of adjusted sire means were estimated: $L_1 = d\ 0\ SF - d\ 14\ SF$ and $L_2 = d\ 14\ SF - d\ 35\ SF$. All L_1 estimates for the different sires were significant except one; estimates ranged from .334 ± .18 kg to 1.269 ± .389 kg with an average value of .868 ± .14. L_2 estimates ranged from -.537 ± .314 kg to .202 ± .39 kg. L_2 contrasts were significant for one sire and approached significance for three sires. Adjusted means for aging periods were 3.62, 3.21, 2.75, 2.97, 2.91 and 2.88 kg for d 0, 7, 14, 21, 28 and 35, respectively (SE were .05 kg for each). These data were also fit to the curve $SF = G + Je^{-Hd}$, where G was asymptotic SF after an infinite aging period, H was estimated rate of change in SF over time, J was the estimated difference between initial SF and G, and d was aging period. Across the entire data set, the estimated G value was 2.96 ± .04, which was slightly larger than the adjusted mean for d 35. The estimated H value of .77 ± .07 was similar to the sum of the L_1 and the L_2 contrast, which was .744. Estimated G and H values were positively correlated (.68 in the overall data set). G and J estimates were negatively correlated (-.51 in the overall data set) and H and J estimates are less strongly negatively correlated (-.17).

Key Words: Warner-Bratzler Shear Force, *Bos indicus*

244 Heritability of Warner Bratzler shear force measures estimated from data on Simmental-sired calves. Z. Zhang*¹, E. J. Pollak¹, R. L. Quaas¹, M. E. Dikeman², R. D. Green³, J. Taylor⁴, and S. Davis⁴, ¹*Cornell University, Ithaca, NY*, ²*Kansas State University, Manhattan*, ³*Colorado State University, Fort Collins*, ⁴*Texas A&M, College Station.*

Progeny of 27 Simmental bulls were scored using the Warner-Bratzler shear force measures done at Kansas State University. These data were collected as part of the National Cattlemen Beef Association's Carcass Merit Project. Along with bulls having progeny, additional animals without records or records on progeny but contributing to the pedigree structure were added to the analysis. A total of 113 pedigree animals were added. The model used to describe the observations contained the effect of age at slaughter (linear and quadratic), contemporary groups (defined as cohorts that were raised and managed together from birth to slaughter with the exception of separating individuals by sex), and an animal effect. A total of 310 progeny with shear force measures were used in the analysis with eight bulls having less than five progeny, eleven with 5 to 10 progeny, five with 11 to 20 progeny, and three with greater than 20 progeny. The additive genetic variance for shear force measures was 0.36kg² and the heritability was 0.48. The range in shear force EPDs for bulls with progeny was -.29 to 0.16 kg for a difference of .45 kg. The additive genetic correlation of shear force measure with marbling, carcass weight, rib-eye area were zero. The correlation with fat thickness, and yield grade were -0.11 and -0.37 respectively.

Key Words: Heritability, Shear Force, Simmental

245 Genetic parameters for intramuscular fat from beef cattle slaughtered at different market weights and finishing regimes. D. J. Johnston*^{1,2}, A. Reverer^{1,2}, and J. M. Thompson^{1,3}, ¹*The Cooperative Research Centre for the Cattle and Beef Industry*, ²*Animal Genetics and Breeding Unit, University of New England, Armidale, Australia*, ³*Department of Animal Science, University of New England, Armidale, Australia.*

Genetic variances and covariances were estimated for chemically measured intramuscular fat percent (IMF) from 3,428 beef carcasses. Cattle

were from four British breeds (Angus, Hereford, Shorthorn and Murray Grey) that were slaughtered at different market weight endpoints. The domestic market group were finished to an average liveweight of 400kg and the export market group to either 520 or 600kg liveweight. Each market treatment group were separated after backgrounding and finished on either pasture or grain. Intramuscular fat percentage was predicted using NIR spectroscopy on a sample of m. longissimus dorsi taken between the 12 and 13th ribs. Export market carcasses had on average 5.4% IMF compared to 3.3% for the domestic market carcasses. Whereas the IMF from grain finished carcasses was on average 5.3% compared to 4.1% from pasture finished carcasses. Heritabilities by market were 0.38 and 0.43 for domestic and export markets, respectively, with a genetic correlation of 0.91 for IMF measured at the two market endpoints. The IMF additive genetic variance was 3.7 times larger for the export market compared to the domestic market carcasses. Heritabilities by finishing regime were 0.30 and 0.46 for pasture and grain finishing, respectively, with a 1.0 genetic correlation between the traits. The additive genetic variance was 2.4 times larger for grain finishing compared to pasture finished cattle. Intramuscular fat can be improved by selection. The high genetic correlations suggest little evidence of a Gx E for IMF across market weight or finishing regimes. However for effective selection the different variances observed will need to be taken into account.

Key Words: Intramuscular fat, Genetic correlation, Gx E

246 Genetic parameters for carcass traits in Simmental cattle at different slaughter end-points. B.C. Shanks*¹, M.W. Tess¹, D.D. Kress¹, B.E. Cunningham², and P.J. Burfening¹, ¹*Montana State University, Bozeman*, ²*American Simmental Association, Bozeman, MT.*

Our objectives were to estimate genetic parameters for carcass traits and evaluate the influence of slaughter end-point on genetic parameters and estimated breeding values (BV). Data provided by the American Simmental Association were divided into three groups: 1) 9,604 records of hot carcass weight (CW) and percent retail cuts (PRC), 2) 6,429 records of CW, PRC, and marbling score (MS), and 3) 1,780 records of CW, PRC, MS, fat thickness (FT), and ribeye area (REA). Weaning weights (WW) from animals with carcass data plus their weaning contemporaries were also used. Data were analyzed with a multiple-trait animal model and REML procedures to estimate genetic parameters and BV at an age-, CW-, MS-, or FT-constant basis. The model for carcass traits included fixed contemporary group and covariates for breed, heterozygosity, and slaughter end-point, plus random additive direct genetic and residual effects. Weaning weight was pre-adjusted for founder effects, direct and maternal heterosis, age of dam, and age of calf. The model for WW included fixed contemporary group and random additive direct genetic, maternal genetic, maternal permanent environment, and residual effects. Within data group, slaughter end-point had only small effects on heritability estimates for all traits. However, differences in heritabilities were detected between groups. Genetic correlations among traits varied across groups and end-points, but suggested it should be possible to select for improved lean yield without sacrificing quality grade. Correlations were calculated among BV computed at different end-points. Adjustment to various end-points resulted in some changes in BV and re-ranking of sires; however, amount of information available had a larger influence than slaughter end-point.

Group	Slaughter end-point	CW	PRC	MS	REA	FT
Group 1	Age	.34	.25			
	CW	-	.25			
Group 2	Age	.35	.24	.36		
	CW	-	.25	.34		
	MS	.33	.25	-		
Group 3	Age	.32	.09	.12	.26	.10
	CW	-	.12	.12	.22	.14
	MS	.30	.09	-	.28	.10
	FT	.33	.17	.13	.29	-

Key Words: beef cattle, carcass, genetic parameters

247 Evaluation of genetic parameters and correlated responses for carcass traits in three lines of synthetic beef cattle. A. Hassen*, R. L. Willham, and D. E. Wilson, *Iowa State University, Ames.*

Carcass information from steer progeny in small, medium, and large synthetic cattle were used to evaluate genetic parameters and genetic trends for carcass traits. Animals were born during 1978 through 1990 at Rhodes and McNay beef research farms. Traits included were hot carcass weight (HCW); longissimus muscle area (LMA); dressing percentage (DP); 12th - 13th rib fat thickness (FTK); and percentage of kidney, pelvic, and heart fat (KPH). All carcass traits were evaluated based on multiple-trait animal model. There were important ($P < .05$) differences in breed direct additive effects between Jersey, Angus, and the Simmental breeds. However, differences in breed maternal additive effects were not different from zero ($P > .05$). Effects of average individual and maternal heterosis were not important ($P > .05$). Heritabilities of HCW, DP, LMA, FTK, and KPH in the small line were .30, .09, .21, .34, and .15, respectively. The respective values in the medium line were .52, .35, .33, .29, and .07. In the large line, heritability values were .31, .18, .17, .31, and .18, respectively. There was an important ($P < .10$) change in mean phenotypic values of animals for HCW, DP, and KPH in all the three lines. However, these changes were largely due to an improvement in the management quality over the years. Sire selection based on weaning indices showed a significant ($P < .05$) genetic change for some of the carcass traits. It was concluded that breeding programs designed to improve carcasses traits need to incorporate carcass information in an index to speedup genetic progress. In this endeavor, evaluation of breeding cattle based on ultrasound measures provides a tremendous opportunity.

Key Words: Beef Cattle, Heritability, Composition

248 Examination of Calpastatin mRNA and Protein to Determine Tenderness in Brangus Cattle. D.L. Wohlford*¹, S.M. Lonergan², J. Wower¹, W.H. McElhenney¹, and L.A. Kriese-Anderson¹, ¹*Auburn University, Auburn, AL*, ²*Iowa State University, Ames.*

Defining factors that influence beef tenderness will play an important role in developing predictors of beef palatability. Using samples from top loin steaks of Brangus bulls ($n=10$) and steers ($n=20$) it has been shown calpastatin activity (CA) and Warner-Bratzler shear force (WBS) values were higher and sensory scores for tenderness (ST) were lower for bulls at 2 and 7 days (d) postmortem (PM) than steers. Also, there were differences in rate of tenderization from 2 to 7 d PM both within and between bulls and steers. Given these results, the purpose of this study was to determine if calpastatin mRNA or protein isoforms were related to 2 d CA, known predictor of WBS. Loin tissue samples from the Brangus bull and steer carcasses characterized for CA, WBS and ST were collected within 15 minutes PM and rapidly frozen in liquid nitrogen. Northern blot analysis was used to quantitate the relative amounts of the 3.8 and 3.0 kb isoforms of calpastatin mRNA. Western Blot analysis using two calpastatin antibodies was used to determine whether there were different isoforms of the protein produced by the different mRNA isoforms and the relative reaction of the calpastatin protein to the antibody. Densitometry was used to quantify the intensity of the signals produced. The GLM procedure of SAS was used to determine whether mRNA or immunoblot densitometry could predict CA, WBS or ST. Independent variables of sex and sire were also included in the model. There were 2 sexes and 11 sires represented in this data. Sires had 1 to 5 progeny each. From the analysis, sex contributed significantly ($P < .05$) in determining CA. Only the intensity of the 3.0 kb mRNA band contributed significantly in determining CA at 7 and 14 d. Likewise, only correlations for the intensity of the 3.0 kb band was significantly correlated with 7 and 14 d CA. Calpastatin mRNA isoforms and calpastatin protein levels were not useful predictors of tenderness of beef in this study.

Key Words: Beef tenderness, Calpastatin mRNA, Calpastatin protein

249 International genetic evaluation of dairy sires using individual performance records and herd clusters. K. A. Weigel*, R. Rekaya, and D. Gianola, *University of Wisconsin, Madison.*

International dairy sire evaluations are presently calculated in a two-step process. Each country estimates national breeding values from local performance records, then these estimates are transformed to the genetic base and scale of other countries using a multiple-trait across-country procedure. However, differences between countries in national genetic evaluation procedures are ignored, and these can lead to biased international breeding values. Further, traits are defined according to country borders, but differences in climate and management within a large country (e.g., Vermont vs. California) can be larger than differences between small neighboring countries (e.g., Netherlands vs. Belgium). This study proposes a multiple-trait herd cluster model for international dairy sire evaluation. A profile of each herd is constructed using information regarding climate conditions, management practices, and the genetic composition of mates. Principal components are calculated from variables corresponding to each herd, and cluster analysis is used to group herds across country borders into unique production systems. The proposed model was applied to 4.6 million first lactation milk records from Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Israel, Switzerland, and five regions of the US. Descriptive variables included: herd size, calving interval, milking frequency, age at calving, milk yield, calving month, sire's genetic merit, sire's percentage of North American genes, latitude, altitude, temperature, rainfall, and percentage of arable land used for pasture. Five clusters were formed, each containing herds from 5-11 countries or regions. Genetic correlations between clusters ranged from 0.81-0.97. The proposed model is appealing because genetic merit is predicted for each unique production system, regardless of country boundaries. It is more parsimonious than the current model (the number of genetic correlations was reduced from 78 to 10), and it is computationally feasible.

Key Words: International evaluation, Dairy sires, Herd cluster

250 Estimation of sire variance in international genetic evaluation models with genetic groups. W.F. Fikse*¹ and P.G. Sullivan², ¹*Interbull Centre, Uppsala, Sweden*, ²*Centre for Genetic Improvement of Livestock, University of Guelph, Canada.*

International genetic evaluations of dairy bulls are currently computed with an across-country sire model based on national genetic evaluation results. The model includes a random effect for the genetic group of unknown parents, to account for genetic trend and different origin of bulls. The question has been raised how treatment of genetic groups affects estimation of sire variances. This study compared two procedures to estimate sire variances, and their impact on international genetic evaluations. A two-country progeny test scheme was simulated for ten generations, where semen was exchanged at a fixed rate from generation three onwards. True breeding values for both populations were sampled from a bivariate normal distribution. Each cow had a lactation record in one country only. All records were used in within population breeding value estimation. Breeding values of bulls were used to estimate sire variances and for international genetic evaluation. The first variance estimation procedure was based on both genetic group and known sire effects, whereas only sire effects were considered in the second procedure. Sire variances were estimated under different assumptions for the variance of genetic group effects, by modifying the constant added to the diagonals of the group effects of the mixed model equations. For a trivial constant, treating groups as fixed, the two procedures are equivalent and underestimated sire variances. When the constant was one, the first procedure yielded empirically unbiased estimates, and the second procedure resulted in slight underestimation. Estimated sire variance increased with higher values of the constant, and the maximum difference between both procedures was 10%. Estimation procedure had no effect on international breeding values, presumably because the ratio of sire variance between populations was unaffected. International breeding values are expected to be affected in situations where the procedures yield different ratios of sire variance between populations, and this is currently under investigation.

Key Words: International Genetic Evaluation, Genetic Groups, Variance Component Estimation

251 Characterization of data and proposed edits for the national calving ease genetic evaluation. C.P. Van Tassel*¹ and C.G. Sattler^{2, 1} *Animal Improvement Programs and Gene Evaluation and Mapping Laboratories, ARS, USDA, Beltsville, MD, ²National Association of Animal Breeders, Columbia, MO.*

Distributions of scores for birth difficulty were examined for herds included in the national genetic evaluation for calving ease. This research was part of an investigation into unusual sire evaluations and was an effort to assess the impact of requiring an identified maternal grand-sire (MGS). Birth difficulty scores ranged from 1, no problem, to 5, extreme difficulty. Data for this study were from the February, 2000 genetic evaluation and included scores from 8,296,832 calvings in 45,243 herds, with 25.7% for records from first parity calvings and 74.3% for second and later parity calvings. The fraction of birth difficulty scores 1 to 5 across herds were 0.65, 0.14, 0.14, 0.05, and 0.03 for first parity, and 0.82, 0.08, 0.06, 0.02, and 0.01 for second and later parities. Sires with suspicious evaluations tended to have a large fraction of records in a herd with an unusual birth difficulty score distribution. To determine useful edits for birth difficulty score distributions, frequencies of scores were summarized by herd-size and parity. Frequencies of observed scores (OS) and cumulative scores (CS) (5, ≥ 4 , ≥ 3 , and ≥ 2) were considered. Herds that exceeded the 95 to 99 percentiles were removed to test potential edits. Thresholds based on OS percentiles resulted in many fewer herds passing the edits than those based on the CS. For example, cutoffs based on the CS 95 percentile resulted in more records being retained than the OS 99-percentile cutoff. Elimination of records without MGS resulted in the loss of 46.1% of the data. For edits based on OS, 50.9% and 79.4% of the records were retained for 95- and 99-percentile cutoffs, respectively, when MGS was not required, and 24.6% and 40.6% when MGS was required. For edits based on CS, 82.4% and 92.6% of the records were retained for 95- and 99-percentile cutoffs when MGS was not required, and 42.5% and 49.1% when MGS was required. These edits were successful in removing 9 and 7 of 9 identified herds using 95- and 99-percentile cutoffs, respectively. A balance between data loss and data quality will need to be determined. Comparison of genetic evaluations from these different subsets of data will be compared to assess the impact of these edits. Based on these results, new edits will be proposed for the national evaluation system.

Key Words: Calving Ease, Genetic Evaluation

252 Prediction of breeding values for Finnish dairy cattle using random regression test day model. E.A. Mantysaari, I. Strandén, and M. Lidauer, *Agricultural Research Center MTT, Jokioinen, Finland.*

A multitrait multilactation model was set up to describe daily observations of milk, protein and fat in all lactations. For each animal separate lactation curve functions were used to determine daily breeding values of traits in the first and the later lactations. In the later lactations the curve functions were treated as genetically repeated observations of the same trait. For each trait the breeding value function consisted of intercept, linear, quadratic and Wilmlink terms. Residuals were modeled by intercept, linear and Wilmlink terms plus a measurement error which were correlated across traits within test days. In addition, model for each later lactation included an extra lactation*cow curve function. Thus, a cow without observations received 6 breeding value curve functions, and a cow with data on 3 lactations another 12 functions for non-genetic animal effects. In the computational model, the dimension of each lactationwise group of functions, 12 or 9 equations, were reduced into 6 coefficients and their eigenfunctions were used as covariables. Environmental effects in model were: stage of lactation, year*month, herd*year, and days carried calf on the time of production and age*parity at calving, and a random effect of herd-test-day. A management auditing software is designed that displays herd-test-day solutions to herd owners.

Data consisted of all test days of cows with 1st calving after Jan 1988. In the February 2000 evaluations the number of animals was 1.51 million and number of observations 25.0 million. This led into 58.5 million equations to be solved. For Ayrshire cows born 1994 the correlations between 305d yield indices derived from test day model and from the old official animal model were .85, .86, and .88, for milk, protein and fat, respectively. For active AI sires the correlations were .97, .95, and .96. The execution time for full evaluation with data preprocessing took 36 hours with a workstation running 4 processors parallel. When old solutions are utilized in a weekly evaluation the time drops to 15 hours.

Key Words: Breeding value prediction, Test day model, Random regression

253 Heterogeneity of (co)variance components for Jersey type traits. N. Gengler*^{1,2}, T. Dusseldorf², G.R. Wiggans³, and J.R. Wright³, *¹National Fund for Scientific Research, Brussels, Belgium, ²Animal Science Unit, Gembloux Agricultural University, Gembloux, Belgium, ³Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

Although a common assumption of genetic evaluation models is homogeneity of (co)variances, this assumption often may be incorrect across time or herds. Data can be adjusted to stabilize (co)variances by contemporary group before evaluation, and this strategy is used for some yield and type evaluations but not currently for US genetic evaluation of type traits for breeds other than Holstein. Most research on type traits has focused on phenotypic heterogeneity of (co)variances for final score. Heterogeneity of (co)variances for Jersey linear and final scores was investigated using February 2000 genetic evaluations. Only first appraisal scores during first lactation from records that included all traits were studied. Three classes of contemporary groups were created based on the number of cows for that herd and appraisal date: 5 to 15, 30 to 55, and 100 and more. In each class, contemporary groups were separated into high (above class mean) and low (below class mean) final score subclasses. The six data sets contained appraisal information from 21,024 to 23,692 cows. (Co)variance components were estimated using expectation-maximization REML and canonical transformation. Across all traits and independent of herd size, phenotypic variances tended to be higher in low-scoring contemporary groups; mean differences in variance were around 30%. Similar or even larger differences existed for genetic variances, but those differences were not as consistent across traits and contemporary group size. The variance differences led to differences in estimated heritabilities: large and high-scoring contemporary groups showed on average around 15% lower heritabilities compared with small and low-scoring groups. Results indicated that phenotypic and genetic (co)variances for Jersey type traits are heterogeneous.

Key Words: Genetic evaluation, Heterogeneous variance, Variance estimation

254 Reliability of progeny tests for reproductive traits computed from DHI data. J. S. Clay*, B. T. McDaniel, and C. H. Brown, *North Carolina State University, Raleigh.*

Animal model methodology was used to compute yearly measures of relative fertility for lactating progeny groups by Holstein AI bulls. Estimates were based upon 70-day non-return (NR70) and days in milk (DIM) at first breeding as reported to DHIA during 1996 to 1998 and computed from breeding records of 1,157,129 daughters of 1,706 bulls with a minimum of 40 daughters. The models assumed heritabilities and repeatabilities of .02, .05 (NR70) and .04, .06 (DIM) and included fixed effects of herd-year-month bred and classes of lactation number, early lactation ECM and days in milk when bred (NR70 only). Valid dam identities were required. NR70s were expressed as differences of NR from average herdmates. DIMs were expressed as differences from herdmates for number of days postpartum of first AI inseminations. Values ranged from -27 to +25 (DIM) and -13 to +15 (NR70). For BVs computed from a minimum of 500 breedings, (78, DIM; 69, NR70)% were within 1 SD of zero and less than (3, DIM; 2, NR70)% were below -2 SD. DIMs computed from few breedings were tested for ability to predict DIMs computed from a minimum of 500 breedings in the same year from different herds. R^2 ranged from .60 ($p < .01$) to .83 ($p < .01$) for DIMs computed from minimum of 20 to 500 early breedings. NR70s were tested for ability to predict NR70s computed from a minimum of 500 breedings in the same year from different herds ($r^2 = .43$ ($p < .01$)). Early BVs computed from few breedings were tested for ability to predict BVs computed from a minimum of 500 breedings in a later year. Betas ranged from .60 (DIM, $p < .05$) and .51 (NR70, $p < .05$) for BVs computed from 100-199 early breedings to .97 (DIM, $p < .01$) and .65 (NR70, $p < .01$) for BVs computed from a minimum of 500 breedings. For yearly estimates based upon a minimum of 500 breedings, only (9, DIM; 21, NR70)% changed by more than 1 SD units; (0, DIM; 10, NR70)% declined by more than 1 SD units. Since both traits were predictable and are important to daughter fertility, an appropriately constructed index could improve both traits.

Key Words: Non-return, Fertility, Reproduction

255 Relationships of PTA productive life of AI Holstein bulls with changes in yield traits from first to second lactation. J.M. Abdallah*¹, B.T. McDaniel¹, and M.J. Tabbaa², ¹North Carolina State University, Raleigh, ²The University of Jordan, Amman, Jordan.

The objective of this work was to investigate the relationships of PTA for productive life (PTAPL) of AI Holstein bulls with early sire evaluations for yield traits. Two data sets were analyzed. In the first, PDs for the difference in milk yield between second and first lactation (PDIFF21) were available from a previous study on AI Holstein bulls widely used in the southeastern US. These were correlated with PTAPLs from the August 1998 USDA sire summary (PTAPL988). Based on sires with at least 10 daughters (n=560) the correlation of PTAPL988 with PDIFF21 was 0.31. The correlation increased to 0.36 for sires with at least 50 daughters (n=319) and 0.41 for sires with at least 100 daughters (n=261). The second analysis included data from the USDA sire evaluations of August 1989 through August 1999. Data included only AI bulls with sampling status of "S" or "M" and for which first and second lactation PTAs were identified (n=3699). All PTAs were adjusted to the same base year. Linear regressions of PTAPL988 on PTAMK1 (first lactation PTA for milk) and PTAMK21 (difference between second and first lactation PTAs for milk) showed that R-square significantly increased from 0.07 for PTAMK1 to 0.12 for both. R-square was 0.09 for the regression of PTAPL988 on PTAPR1 (first lactation PTA for protein) and increased to 0.14 by adding PTAPR21 (difference between second and first lactation PTAs for protein). The regressions of PTAPL988 on PTAs for fat yield showed that fat was less important in predicting productive life than milk and protein. These results show that PDs or PTAs for the change in milk yield from first to second lactation should be useful predictors of productive life. Considering the difference between second and first lactation PTAs of milk and protein should improve the prediction of PTAs for productive life for little cost.

Key Words: Correlations, Productive life, PTAs

256 Stability of yield evaluation for Holstein bulls in artificial-insemination service. R.L. Powell*, H.D. Norman, and G.R. Wiggans, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD.*

The dairy industry has expressed concern that bull evaluations for yield traits decline too often. Although changes in genetic evaluations with additional data are accepted, earlier evaluations are expected to be unbiased; i.e., individual bull evaluations may increase or decrease, but means for any subset of bulls should remain the same. To examine evaluation stability, January 1995 genetic evaluations of yield traits for 540 Holstein bulls in active artificial-insemination (AI) service at that time were compared with their February 2000 evaluations. Mean changes in predicted transmitting ability (PTA) were small (-9 kg, milk; -1.4 kg, fat; -0.5 kg, protein), whereas mean reliability (REL) increased from 81.8 to 96.1%. Forty bulls with low (<70%) reliability in 1995 had much larger changes in PTA (-63 kg, milk; -2.4 kg, fat; -1.6 kg, protein) than did 97 bulls with high (≥90%) REL in 1995 (+11 kg, -0.2 kg, +0.3 kg). Bulls in the top decile for PTA milk in 1995 had the largest declines in PTA (-50 kg, milk; -4.4 kg, fat; -2.5 kg, protein), whereas mean PTA for bulls in the lowest decile were nearly unchanged (+2 kg, -0.4 kg, +0.3 kg). Mean PTA of the 406 bulls from traditional AI organizations (a National Association of Animal Breeders controller number of ≤29) were fairly stable (-5 kg, milk; -1.3 kg, fat; -0.4 kg, protein), but declines in PTA for the other 134 bulls were larger (-23 kg, -1.8 kg, -0.8 kg). Changes in PTA were correlated positively with initial REL and negatively with change in REL over 5 yr. Similar results were found for active AI bulls in February 1997, except that PTA tended to decline more often overall. Thus, active AI bulls tended to decline in PTA, particularly for bulls with lower REL, higher PTA, and from less traditional AI organizations. Overevaluation of such bulls will be reexamined after implementation of model and base changes in the national system for genetic evaluations in August 2000.

Key Words: Genetic evaluation, Artificial insemination, Stability

257 A multivariate approach for analysing longevity in dairy cattle. B. L. Harris¹ and A. M. Winkelman¹, ¹Livestock Improvement Corporation, Hamilton, New Zealand.

The objective of this study was to find a means for improving the timeliness and accuracy of the New Zealand's national genetic evaluation for survival. A new trait, longevity, was defined as days survived from birth until last known test day. Longevity was chosen because the trait better modelled the culling process that occur continuously over the milking season compared to the current binary survival indicators measured for each lactation until the fifth lactation. Survival analysis was used to assess the contribution of production and non-production traits in the prediction of longevity. The results of the survival analysis were used to extend incomplete longevity records (censored records) by using the mean residual life function. A multiple trait animal model with missing data was used to produce breeding value estimates for longevity. The multiple trait model had six traits; life expectancy recorded when the cohort group is completing the first lactation, life expectancy recorded when the cohort group is completing the second lactation and so on with trait 6 being life expectancy recorded when the cohort group is beyond the fifth lactation. The accuracy of the multiple trait method was compared with alternative approaches.

Key Words: Longevity, Multiple trait, Animal model

258 Genetic variations in milk somatic cell count in different age at calving within parity of Hungarian Holstein Friesian. A. Amin*¹, ¹Department of Animal Production, Faculty of Agriculture, Suez Canal University.

Hungarian Holstein Friesian lactation records and sample test day of somatic cell count (SCC), daily milk yield (DY), fat % (F%), protein % (P%), lactose % (Lac%), and milk yield-305 (M-305) were examined and estimates of variance components were obtained. Sire-cow animal models by MTDFREML were used to compute estimates of heritability, genetic and phenotypic correlations for all studied traits. 255734 lactation records involved four parities were collected from five herds of 12 farms during the period from 1991 to 1993. Overall estimates of lactation heritability were 0.28, 0.23, 0.39, 0.40, 0.42, and 0.29 for SCC, DY, F%, P%, Lac% and M-305 respectively. The highest heritability estimates for all studied traits are presented in the 2nd and 3rd parity. Estimates of h^2 SCC increased steadily with monthly test day and ranged from (0.09 to 0.22). The highest h^2 of DY (0.31 in the 2nd test day) associated with the moderate h^2 of SCC (0.12). Overall genetic and phenotypic correlation between SCC and DY were -0.29 and -0.31 respectively. The maximum genetic correlation between SCC and DY among calving age groups obtained at 20.1 to 24.0 mo (-0.30) and the corresponding maximum phenotypic association was -0.32 in calving group of >= 44.0' mo. The highest phenotypic correlation between SCC and milk compositions was found for P% in the overall and the 2nd parity estimates. Relationship between milk compositions was high and positive. Genetic and phenotypic (co)-variances generated by the suggested animal model indicated that SCC could play an important role in improving of milk production and in decreasing the possible rates of mastitis Incident by an appropriate selection index.

Key Words: Somatic cell, Genetic and phenotypic correlation, Fat, Protein, Lactose

259 Routine genetic evaluation for functional longevity in dairy cattle populations in Switzerland. Natascha Vukasinovic*¹, J. Moll², and L. Casanova², ¹Dept. of Mathematics & Statistics, Utah State University, Logan, ²Swiss Brown Cattle Breeders Association, Zug, Switzerland.

Genetic evaluation of sires for functional longevity of their daughters based on survival analysis has been implemented in the populations of Braunvieh, Simmental, and Holstein cattle in Switzerland. A Weibull mixed sire-maternal grandsire survival model was used to estimate breeding values of sires, using data on cows calved from April 1, 1980 onward. Data on Braunvieh and Simmental cows included over one million records, data on Holstein cows comprised about 250,000 records. The data contained approximately 20% censored records. Besides the random sire and maternal grandsire effect, the model included effects of herd-year-season, age at first calving, parity, stage of lactation, alpine pasturing (Braunvieh and Simmental), and relative milk yield and relative fat and protein percentage within herd to account for culling for

production. Heritabilities of functional longevity, estimated on a subset of data including approximately 150,000 animals, were .18, .20, and .18 for Braunvieh, Simmental, and Holstein, respectively. Breeding values were estimated for all sires having at least 6 daughters or 3 granddaughters in the data. Breeding values of sires can be expressed in genetic standard deviations or in days of functional productive life and published in sire catalogs along with breeding values for production traits.

Key Words: survival analysis, functional longevity, sire evaluation

260 Approximate ETA for lifetime production based on genetic evaluations for lactational production and herd life. P.J. Boettcher¹ and F. Miglior², ¹University of Guelph, Canada, ²Canadian Dairy Network, Guelph, Canada.

Dairy cattle breeders in Canada have expressed an interest in a genetic evaluation of sires for lifetime production of their daughters. Lifetime production is a function of production per lactation and the number of lactations expressed. In Canada, genetic evaluations are currently available for lactational production and herd life (HL). The objective of this study was to use the existing genetic evaluations to develop approximate ETA for lifetime production. The approach taken was to multiply ETA for production in each lactation by their respective probabilities of expression and then sum across lactations. Direct application of this proposed approach was limited by three factors: 1) EBV for production are calculated for only the first three lactations, 2) ETA for HL are for functional HL rather than true HL, being adjusted for effects of production, and 3) ETA for HL are expressed as the expected total number of lactations survived. Selection index theory was used to develop EBV for lactations >3 based on EBV for lactations 1 to 3. Regression was used to convert ETA for functional HL to true HL. Survival analysis theory was used to convert ETA for HL into probabilities of expression for each lactation. The probability of culling was assumed to follow a Weibull distribution. The Weibull survivor function (probability of survival to lactation $t = \exp[-(\lambda t)^r]$) was fit to average survival rates in Canada to establish a base-line. The best fit occurred when $\lambda=0.262$ and $r=2.0$. The ETA for true HL of sires (expressed as a difference from the average of 3.0 lactations) were then fit as covariables with $\beta = -0.617$. Based on these parameters for the survivor function, the proportion of daughters from a given sire that survived to express lactation t was $= \exp[-(0.262t)^2] \exp[-0.617(ETA-3.0)]$. Production ETA and survival proportions were calculated within each lactation and their products were summed across lactations to yield the final ETA for lifetime production.

Key Words: Lifetime Production, Approximation

261 Genetic parameters for three experimental feet and leg traits for Canadian Holsteins. P.J. Boettcher¹, L.R. Schaeffer¹, J. Fatehi¹, and J.J. Shannon², ¹University of Guelph, Canada, ²Canadian Holstein Association, Brantford, Canada.

In March 1998 the Canadian Holstein Association started to record three new feet and leg traits as part of their routine type classification. Traits were rear legs from the rear view, depth of heel, and claw uniformity. All traits were recorded on a nine-point scale, which is the standard for descriptive conformation traits evaluated by Holstein Canada. For rear legs-rear view, cows received lower scores if they hocked-in more severely. Cows with more depth of heel received greater scores. Cows with symmetric claws (right rear foot) received high scores and scores decreased as uniformity in shape and size of the claws decreased. More than 200,000 cows were scored over 15 months of classification. Due to expected increases in experience and precision of the classifiers, genetic parameters were estimated using 57,492 records from first lactation cows scored during the final 15 months of classification. Genetic parameters were estimated using a Bayesian procedure that employed Gibbs Sampling. Genetic relationships among the three traits and eight other conformation traits were estimated in a series of four 5-trait (3 experimental and 2 other) animal models. Factors in the model were herd*round*classifier, age and stage of lactation during classification, and animal. For each five-trait combination, six chains of 30,000 cycles were generated, discarding the first 5000 cycles in each chain. Means across chains were used as the point estimates of the parameters of interest. Heritabilities were 0.110, 0.096, and 0.045, for rear legs-rear view, depth of heel, and claw uniformity, respectively. Genetic correlations with rear legs-rear view were 0.34 and 0.55 for heel depth and claw uniformity. Genetic correlation between heel depth and claw uniformity

was 0.66. Foot angle and overall feet and legs had high correlations (>0.65) with claw uniformity.

Key Words: Conformation, Feet and Legs, Genetic Parameters

262 Estimation of variance components for cow and parity effects from test-day yields. J. Bormann¹, G.R. Wiggans², J.C. Philpot², T. Druet^{1,3}, and N. Gengler^{1,3}, ¹Animal Science Unit, Gembloux Agricultural University, Gembloux, Belgium, ²Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD, ³National Fund for Scientific Research, Brussels, Belgium.

The initial step in implementation of a US test-day model includes estimation of cow and parity test-day variances needed to calculate lactation stage, age, and pregnancy effects. Single-trait repeatability models were fitted, and variance components were estimated for milk, fat, and protein test-day yields using Method R and a preconditioned conjugate gradient (PCG) equation solver because of large data sets (0.7 to 7.7 million records). Data were obtained for calvings since 1990 for Brown Swiss and Jerseys and for Holsteins from California, Pennsylvania, Texas, and Wisconsin. A minimum of three observations were required per subclass for herd test date and milking frequency. Three parity groups were defined: first, second, and later. Test-day data were adjusted for environmental effects of age, calving season, and milking frequency. Estimated breeding values (EBV) were expressed on a daily basis. To assess effect of adjustments, data also were analyzed without correction. For adjusted data, variance ratios (residual divided by variance of effect) within parity were similar across breeds, subpopulations, and samples: 1.5 to 1.8 for milk, 3.0 to 4.3 for fat, and 1.8 to 2.3 for protein. Variance ratios across parities ranged from 3.5 to 6.8 for milk, 8.7 to 17.6 for fat, and 5.5 to 9.4 for protein. Adjustment for EBV reduced both cow genetic and nongenetic variances. Variance ratios for permanent environment within parity from unadjusted data were nearly identical to those from adjusted data. For unadjusted data, heritabilities ranged from 0.19 to 0.30 for milk, 0.13 to 0.15 for fat, and 0.17 to 0.23 for protein. Although computations took several weeks, use of Method R and a PCG solver enabled estimation of the variance components that will be used for US evaluations based on a test-day model.

Key Words: Test-day model, Genetic evaluation, Variance estimation

263 Optimizing single-generation selection on QTL in crossbreeding programs. J. C. M. Dekkers¹ and R. Chakraborty¹, ¹Iowa State University, Ames.

Molecular genetics has enabled detection of quantitative trait loci (QTL) in livestock. The use of QTL in selection requires a balance between the QTL and other genes (polygenes). For non-additive QTL, standard QTL selection, in which selection is on the sum of the standard EBV for the QTL and an EBV for polygenes, does not maximize progeny performance, as illustrated by Dekkers (1999, Genet. Sel. Evol. 31:421) for purebred selection. Often, however, the aim is to maximize crossbred performance. Therefore, the objective here was to develop methods to optimize single-generation purebred QTL selection for a 2-breed terminal cross. A deterministic model for within-line selection on an index of the known breeding value for a QTL and a purebred EBV for polygenes was developed. For simplicity, crossbred progeny were produced by random mating of unselected male and female progeny from the sire and dam lines. Lagrange multiplier methods were used to develop iterative algorithms that maximized crossbred performance. Optimal QTL selection was compared to standard purebred QTL selection for a biallelic QTL with 30 and 40% frequencies in the male and female line and 10 and 25% selection of sires and dams within each line. Optimal QTL selection resulted in greater crossbred performance for dominant QTL. Extra responses were 1, 5, and 12% greater for QTL with partial, complete, and over-dominance for a QTL with an additive effect (a) of 1 polygenic EBV standard deviation, and 3, 11, and 37% greater for a QTL with an equal to 3 polygenic EBV standard deviations. Optimal selection strategies differed by line and resulted in opposite trends in QTL frequencies for over-dominant QTL. Pure-line responses under optimal selection were similar to standard QTL selection for the male line but substantially less for the female line. In conclusion, QTL information

can be used to select for improved crossbred performance based on purebred data. The impact on multiple generation response requires further investigation. This research was funded by Pig Improvement Company.

Key Words: Marker Assisted Selection, Cross Breeding

264 Verifying the hypothesis of more than one QTL on chromosome 6 influencing the relation between both yield and percentage of milk protein and milk fat. G. Freyer*¹, C. Kuehn¹, and I. Hoeschele², ¹Research Institute for the Biology of Farm Animals, ²Virginia Polytech Institute and State University, Blacksburg.

Earlier studies, e.g. those involving data of 1721 Black and White cows, led to the hypothesis of the existence of more than one QTL on the bovine chromosome 6 for several milk production traits (Freyer et al. 1999, *J Anim Breed and Genet* 116:87-97). The Casein loci have been used as markers. These results suggested a QTL for fat yield, protein yield and fat percentage close to the Casein locus, while a QTL only moderately linked with the Casein locus affected fat percentage in the study mentioned. It has been shown that an adjustment of cows performances for the effects of their kappa and beta Casein genotypes reduced the genetic correlation coefficient between milk yield and fat percent from -.36 to -.31 and of milk yield and protein percent from -.33 to -.26. Here, we are using different statistical approaches fitting more than one QTL with the aim of comparing the results with respect to the number, locations and effects of the QTL involved. Methods compared are two different implementations of variance component analysis (REML) in the programs SOLAR and MQREML, and Least-Squares analysis. First results using data from a grand-daughter design in the German Holstein Friesian population provide evidence for two QTL and confirm a QTL for fat yield (Kuehn et al. *Anim Genet* 30(1999),33-34)). Results of the three statistical methods led to nearly equal inferences concerning the QTL location. Putative QTL for milk yield, fat yield and protein yield are located with a high probability between 40 - 68 cM and 88 - 105 cM. QTL for protein percentage are probably located between 7 - 66 cM and 75 - 95 cM, respectively, with map positions derived using Haldane's mapping function. The 95% confidence interval for yield traits cM is 1 to 89 cM and 40 to 102 cM, for protein percentage 0 to 76 cM and 43 to 102 cM. Because the Casein genes are located at 95 cM (Kosambi) there is a further support for the assumption of the hypothesis. For fat percentage, QTL appeared to be segregating only in a few families and did not attain significance.

Key Words: Dairy cattle, QTL detection, Trait relation

265 Accounting for uncertainty of QTL location in marker assisted selection in dairy cattle. A. Stella*, J. Gibson, and G. Jansen, *University of Guelph, Ontario, Canada.*

The objective of this study was to evaluate whether the efficacy of marker assisted selection (MAS) could be improved by considering a confidence interval (CI) of QTL position. Specifically, MAS was applied for within-family selection in a stochastic simulation of a closed nucleus herd. The location and effect of the QTL were estimated by least squares interval mapping with a granddaughter design. Three generations were simulated. Nucleus size was 5 sires and 250 dams. Genotypes and EBV from the first two generations were used to identify probable QTL. This information was then used in the third generation to select bulls from within full-sib families for entry into a progeny testing program. Six markers on a single chromosome were evenly spaced around a QTL. Each marker had 6 alleles and the QTL had ten alleles, with normally distributed effects. The QTL explained 17 % of the total genetic variance. Heritability was either .10 or .30. Three approaches were used to select the best bull within fullsibships of 3 or 40 bulls. All three were based on the probability of inheriting the favorable allele from the grandsire (PROB). The first method selected the sib with the highest PROB at the location with the highest F-ratio (MAXF). The other two approaches were based on sums of estimated regression coefficients weighted by PROB at each cM within a 95 % CI based on either bootstrapping (BOOT) or approximate LOD scores (LOD). Selection criteria were compared with the following measures: 1) average BV of the selected bulls and 2) frequency of selected bulls inheriting the favorable allele. The average BV of the selected bulls was increased by 1.7, 2.3 and 2.5 % when MAS was applied using MAXF, BOOT and LOD, respectively compared to random selection ($h^2 = .30$). When heritability was .10, gains were reduced to 1.7, 2.0 and 2.0 %. Selected bulls

carried the correct allele in 78, 71, 71 and 63 % of the cases for MAXF, BOOT, LOD and random selection respectively. Little advantage was observed when using a CI to account for uncertainty in QTL location.

Key Words: Marker-assisted selection, Confidence interval, Dairy cattle

266 Stochastic estimation of exclusion probabilities. S. D. Kachman*¹ and G. B. Sherman¹, ¹University of Nebraska, Lincoln.

Microsatellites provide a powerful tool for paternity identification. However, the cost associated with obtaining microsatellite information can be high. Depending on a number of factors the probability of unambiguously identifying the sire of a calf in a breeding group can be small. A program to predict the exclusion probabilities and probabilities of unambiguous parentage based on the genotypes of the bulls has been developed. Using the genotypic information the program estimates, for each bull, the probability that his calves can be unambiguously assigned to him and the probability that each of the other bulls can be excluded as a sire of the calf. Genotypic information at 11 loci for 33 bulls was used to estimate the probability of unambiguous parentage. The program estimated an overall probability of unambiguous parentage of 73% for a group of 33 bulls that were co-pastured in a single large breeding group. The result agreed favorably with the observed frequency of 80% of the calves resulting from this breeding being assigned to a single bull.

Key Words: exclusion probability, microsatellite

267 Discovery of novel genes controlling feed intake in cattle. D. R. Glimm*¹, F. Dong¹, P. K. Chelikani¹, E. K. Okene², G. R. Khorasani¹, and J. J. Kennelly¹, ¹University of Alberta, ²Western Forage/Beef Group, Lacombe Research Centre, Alberta, Canada.

An experiment was conducted with five Holstein cattle fitted with duodenal cannulae to identify and characterize gastrointestinal genes that are differentially expressed during conditions of hunger or satiety. Intestinal tissue samples were obtained from the duodenum, approximately 50-cm distal of the abomasal sphincter, by endoscopy (Olympus CF type 1B) at five time points during fasting (48 h) and five time points during refeeding (24 h). Gastrointestinal genes that were differentially expressed over the course of fasting and refeeding were identified using expression genetics technology (differential display). So far, we have identified 60 genes that exhibit temporal patterns of expression during conditions of increasing hunger or satiety. The expression of some of the genes appeared to be turned off during conditions of extreme hunger that accompany prolonged fasting. In contrast, other genes were expressed only during conditions of extreme hunger. The expression of the remaining candidate genes was either substantially increased or decreased during fasting or refeeding. The 30 combinations of primers that we have used so far however, represent only about 30% of the theoretical number required to ensure statistically that all expressed genes are surveyed. The cDNA fragments corresponding to all candidate genes have been isolated and are at various stages of characterization. Comparison of sequence data from those that we have cloned with existing DNA sequence databases reveals that about 70% of our candidate genes have never before been identified or sequenced in any species. To confirm differential expression and further characterize candidate genes, we have generated antisense riboprobes from our clones and successfully used them to perform northern hybridization and ribonuclease protection assays. Our study demonstrates that expression genetics technology provides a powerful new experimental approach for the discovery of novel genes that encode proteins with key roles in regulating hunger and satiety in cattle.

Key Words: Feed Intake, Expression Genetics, Gastrointestinal Physiology

268 The National Animal Germplasm Program. H. D. Blackburn*¹ and S. M. Kappes², ¹USDA-ARS, Ft. Collins, CO, ²USDA-ARS, Beltsville, MD.

The National Animal Germplasm Program (NAGP) was established in 1999 to develop a national system for conserving and utilizing animal genetic resources. Within ARS the national system is comprised of a central repository and three satellite repositories. The repository system is responsible for the collection and maintenance of cryopreserved animal germplasm and tissue that represents the breadth of U.S. animal

genetic resources. Germplasm is collected in conjunction with other research institutions and industry. In addition to preserving germplasm the program is to develop a database and decision support tools that assist in management of genetic resources. Much of the database and information system will be accessible on the NAGP website. For livestock species and aquaculture there are species committees comprised of research and industry members that assist in the identifying and collecting germplasm. Presently the system has stored three swine germplasm lines and 52 poultry lines. For small ruminants the Gulf Coast Native, Navajo-Curro, Myotonic Goat and Angora goat have been identified as potentially at risk populations. As a result conservation strategies are developed to monitor and collect germplasm from those breeds should conditions so dictate. The comprehensive approach taken in development of the NAGP should result in a national resource that allows preservation, utilization and characterization of animal genetic resources.

Key Words: Genetic conservation, Animal genetic resources, Cryopreservation

269 Reproductive and maternal performance of Angus-, Brangus-, Gelbvieh-, Gelbray-sired, and F₁ Brahman-Hereford cows. S.M. DeRouen* and J.M. Turpin, Louisiana State University Agricultural Center, Homer.

A total of 738 reproductive and 485 calving records were collected from straightbred-sired, Brahman composite-sired, and F₁ Brahman-Hereford (BH) females from 1995 to 1999. Angus (A), Brangus (BA), Gelbvieh (G), and Gelbray (GB) bulls were randomly mated to BH cows to produce spring- and fall-born heifers. Contemporary weaning-aged BH heifers were purchased when other heifers were weaned. Percent Brahman inheritance was 25% in A- and G-sired females, 44% in BA- and GB-sired females, and 50% in BH females. After weaning, heifers were developed on a forage-based diet. Heifers were exposed to Red Poll bulls during a 60-d spring breeding season to first calve at 2.0 or 2.5 yr of age. Thereafter, cows were exposed to Simmental bulls during a 60-d spring breeding season. Calves were weaned in late September of each year at an average age of 210 d. Non-pregnant females were culled from the study. Separate analyses were conducted for first exposure, primi-, and multiparous females using a generalized linear mixed model procedure. Dam breed type affected ($P < .05$) pregnancy rate for first exposure and primiparous 2 yr old heifers with BA-sired females having rates that were 22 to 37% lower ($P < .05$) than A-, G-, GB-sired, and BH females. Dam breed type did not influence ($P = .27$) pregnancy rate (overall mean=93%) for multiparous cows. Dam breed type tended ($P < .08$) to affect calf 205-d weight from primiparous females with calves from BH cows being 11 kg heavier ($P < .05$) than calves from A-, BA-, G-, and GB-sired cows. Calf 205-d weight from multiparous cows tended ($P < .08$) to be influenced by dam breed type and were 233, 236, 235, 232, and 250 kg for A-, BA-, G-, GB-sired, and BH cows, respectively. These data suggest that lower reproductive performance was exhibited by BA-sired females during their first and second exposures, and improved maternal performance was achieved by BH females relative to the other dam breed types included in this study.

Key Words: Breed crosses, Reproduction, Maternal performance

270 Evaluation of body measurements of Charolais cows. J. Tözsér¹, F. Szabo*², Z. Domokos³, G. Tözsér¹, and E. Szuics¹, ¹Szent Istvan University, Godollo, ²University of Veszprem, Georgikon Faculty, Keszthely, ³National Association of Hungarian Charolais Cattle Breeders, Miskolc, Hungary.

Charolais cows (n=311) of 6.8 years of average age and 600 kg average live weight were examined in summer grazing period in 1998. Live weight (LW), height at withers (HW), rump width 2 (RW), slanting body length (SBL) as well as chest girth (CG) were recorded simultaneously. The data were statistically analyzed using the SPSS 7.5 software package. Phenotypic correlation were computed by the covariance component and variance component estimates. Multiple relationship among traits listed above were investigated by principle component analysis after varimax rotation. Separated position of age was tested by cluster analysis. Means and SD for HW, RW, SBL and CG were 132.2±3.93; 52.1±2.74; 177.2±8.09 and 194.5±8.50 cm, respectively. Bivariate phenotypic correlation coefficients between traits reveal close relationship of body measurements on BW (BW vs. HW: r=0.54, $P < 0.001$; BW vs. RW: r=0.63, $P < 0.001$; BW vs. SBL: r=0.63, $P < 0.001$; BW vs.

CG: r=0.83, $P < 0.001$). High multiple correlation coefficient ($R = 0.88$, $P < 0.001$) was found among independent variables (RW, SBL, CG) and BW (dependent variable) by stepwise regression analysis. Relatively low relationship was shown between age of animals and body measurements ($r = 0.04 - 0.26$). Two factor loadings proved to be statistically significant, as follows: factor I for body weight - body measurements (variance: 3.2310, ratio of variance: 53.8%) and factor II of age (variance: 1.1032, ratio of variance: 18.4%). In conclusion, main role of SBL and CG ($R=0.60$; $P < 0.001$) in HW of cows was elucidated by stepwise regression.

Key Words: Body measurements, Variance, Phenotypic correlation

271 Characterization of maternal productivity in the Hereford breed. C. Gallivan, D. H. Crews, Jr., P. B. Mwansa*, and R. A. Kemp, Lethbridge Research Centre, AAFC, Alberta, Canada.

A review of the literature was conducted to characterize the Hereford breed for maternal productivity. Over 300 papers published since 1965 covering approximately 18 cattle breeds from Canada, the US, Australia, New Zealand and the UK were evaluated. For all traits, the model included the location of study, age of cow, % of inheritance from each of the cow breeds, and the heterozygosity of the cow. In addition, % of inheritance from each sire breed, and the heterozygosity of the calf were also included in the models for the following traits: % of cows exposed that calved (PCAL; n=27,290), calf birth weight (BWT; n=36,588), % of calves alive at weaning (PLWN; n=30,298), % of cows exposed that weaned a calf (PEWN; n=27,449), calf preweaning average daily gain (ADG1; n=31,071), calf age-adjusted weaning weight (WWTa; n=58,465), WWTa per cow exposed (WWTa:CE; n=28,855), and the ratio of the weight of the calf weaned to the weight of the cow at weaning (WWT:CWWT; n=457). The Hereford reaches puberty at an average age of 343.68±9.87 d and an average weight of 253.65±3.31 kg. With the exception of the Angus and the dairy breeds that reached puberty earlier, and the Charolais, which was heavier at puberty, the results for the Hereford were comparable to those of the rest of the breeds considered. It was shown that crossbred cows reached puberty 21.12±8.58 d earlier and 10.48±2.88 kg heavier than purebreds. The Hereford pregnancy rate of 81.37±0.99% was either similar or superior to all the other breeds considered, except for Red Poll, Brown Swiss and Shorthorn. An average BWT of 34.38±0.28 kg for the Hereford breed was lower ($P < .05$) than most of the other breeds. The Hereford was equal or superior to all the other breeds for PLWN. Average ADG1 and WWTa for the Hereford were lower than other breeds considered. Generally, no differences ($P > .05$) were observed for WWTa:CE among the breeds considered. Analysis of weight, height and condition score of cows tended to characterize the Hereford as a breed that is moderate in size and able to maintain condition relative to other breeds and types.

Key Words: Hereford, Maternal Productivity, Breed Effects

272 Genetic parameter for meat quality traits evaluated by image analysis method in Japanese Black. K. Kuchida*, Y. Hamasaki, M. Suzuki, and S. Miyoshi, Obihiro University of Agriculture and Veterinary Medicine, Japan.

Carcass values are greatly influenced by marbling scores in Japan. Marbling scores assigned by graders (GRADE_MS) are comprehensively evaluated, considering the ratio of marbling area to ribeye area (FATPER), coarseness of marbling (COARSE), shape of marbling (SHAPE), dispersion of marbling particles in the ribeye area (DISP), etc. The purposes of this study were to calculate FATPER, COARSE, SHAPE, and DISP numerically by image analysis method and to estimate genetic parameters for meat quality traits involving these image analysis traits. Digital images of the ribeye area from the 6th to 7th rib cross section of 923 Japanese Black steers with GRADE_MS were used in this study. The image analysis traits were calculated using image analysis software programmed by authors. A marbling score (PRED_MS) was predicted using the multiple regression analysis with image analysis covariates by the STEPWISE method. Genetic parameters for carcass traits assigned by graders were estimated with an animal model using the multitrait REML program by canonical transformation. Genetic parameters for image analysis traits were predicted simultaneously. Heritability estimates of GRADE_MS, carcass weight (CWT), ribeye area (RIBEYE), and subcutaneous fat thickness (SFT) were 0.48, 0.57, 0.48, and 0.34, respectively. Those of FATPER, COARSE, SHAPE, DISP, and PRED_MS were 0.58, 0.27, 0.35, 0.47, and 0.52, respectively. Genetic correlations

between GRADE_MS and FATPER, and GRADE_MS and PRED_MS were highly positive (0.98 and 0.97 respectively). Genetic correlations between PRED_MS and CWT, and PRED_MS and RIBEYE were 0.22 and 0.37, while those between GRADE_MS and CWT, and GRADE_MS and RIBEYE were slightly lower; 0.11 and 0.24. These results indicate that image analysis traits can be good indices of breeding improvement.

Key Words: Image analysis, Japanese Black, Genetic parameters

273 Evaluation of the heritability values of the most important traits of beef cattle. F. Szabo^{*1}, Z. Lengyel¹, Z. Wagenhoffer¹, and J. Dohy², ¹University of Veszprem, Georgikon Faculty of Agriculture, Department of Animal Husbandry, ²Szent Istvan University Godolo, Department of Animal Science.

Heritability values of the most important traits of beef cattle were evaluated on the basis of great number (n= 2691-7084) of animals in Hungary. Data for the evaluation were collected in straightbred and crossbred population of Hungarian Simmental and Hereford breeds in different farms. The statistical evaluation of the data was carried out using with analyses of variance of progeny groups using SAS Version 6, and the Last Square and Maximum Likelihood Computer Program (Harvey, 1990). As a results of the study, no statistical differences (P>0.05) were found as for the heritability values between the straightbred and crossbred population. During the study the averages of the heritability values (h²) were found as follows: gestation length 0,46, birth weight 0,39, calving difficulty 0,07, unassisted birth 0,11, caesarean section 0,10, calf loss or survival rate to weaning 0,07, weaning weight of the calves 0,29, 200-day weight of the calves 0,19, 400-day weight of the heifers 0,47, 550-day weight of the heifers 0,45, rate of the heifers showed oestrus at a given age 0,31, age at puberty of heifers 0,37, daily gain during the fattening period 0,50, final weight 0,43, carcass weight 0,39, carcass percentage 0,32, rib eye area 0,59, fat thickness 0,54, kidney, pelvic and heart fat percentage 0,68, marbling 0,37, tenderness 0,50, prime meat weight 0,50, prime meat percentage 0,64, fat trim weight 0,49, fat trim percentage 0,58, bone weight 0,49, bone percentage 0,46.

Key Words: reproduction, growth, carcass value

274 Genetic correlation estimates for weaning weight and postweaning gain across Hereford populations in four countries. D. Lee* and J. Bertrand, University of Georgia, Athens.

Original data consisting of 45,831, 522,065, 116,232 and 2,367,857 weaning weight (WWT) records and approximately 40 to 55% less postweaning gain (PWG) records from the Hereford Associations of Argentina (AR), Canada (CA), Uruguay (UY) and the United States (US) were used to estimate genetic correlations across pairwise sets of countries treating WWT or PWG as a different trait in each country. The PWG in CA and US was an adjusted 160 day gain, and in AR and UY, PWG was adjusted to 247 days. A previous research study had found that the direct and maternal (in parenthesis) genetic correlations, treating WWT as a different trait in different countries in pairwise data sets, were estimated at .88 (.84), .86 (.82), .90 (.85), for CA-UY, CA-US and US-UY, respectively. An analysis of WWT in the present study for AR-CA and AR-US found genetic correlation estimates of .81 (.78) and .78 (.77), respectively. Based on these two studies, it appears that the four countries can be considered as a single population for the genetic evaluation of weaning weight. To examine the genetic correlations across countries for PWG, pairwise sample data sets were created by randomly sampling herds that had PWG records, had greater than 500 WWT records, had a herd average WWT contemporary group size that was greater than nine calves, and had progeny or grandprogeny from sires used across each pairwise set of countries. A multiple-trait animal model that considered WWT as the same trait in each country, but considered PWG as a different trait in each country was fit to the data in each pairwise analysis, using an EM-REML algorithm. The direct genetic correlations for PWG were .29, .35, .43, and .43 for AR-CA, AR-US, CA-UY and US-UY, respectively. The research to this point suggests that PWG should not be considered as the same trait for animals with progeny in both North American (CA and US) and South America (AR and UY) for the purposes of genetic evaluation.

Key Words: Genetic correlations, Across-country evaluation

275 Differences between optimum and actual feed intake of various pig genotypes, and consequences for selection. E. Kanis^{*1}, J.J. Eissen¹, J.W.M. Merks², and K.H. de Greef³, ¹Wageningen Institute of Animal Sciences, Wageningen University, The Netherlands, ²IPG, Institute for Pig Genetics BV, Beuningen, The Netherlands, ³Institute for Animal Science and Health, ID-Lelystad, The Netherlands.

Feed intake (FI) in growing and finishing pigs is a trait with an economic optimum (FI_o). Therefore, the desired selection direction for ad libitum feed intake or feed intake capacity (FIC) in the purebred lines of a breeding program depends a.o. on the FIC of the commercial end products relative to their FI_o. To estimate FI_o in various pig genotypes, an experiment was carried out with five genotypes from two breeding companies during three phases of the growth period (25-65, 65-95 and 95-125 kg live weight). Per combination of genotype, growth phase and sex, FI_o was defined as FI just sufficient to reach maximum protein deposition (PD_{max}), assuming a linear-plateau relationship between daily PD and daily FI. Pigs were housed in groups but feed intake was measured individually. The feed contained 15.1 MJ DE, 170-191 g crude protein and 9.0-10.6 g lysine per kg. The five genotypes consisted of two end product genotypes (gilts and barrows), two dam line genotypes (gilts) and one purebred genotype (gilts, barrows and boars). In total 1019 pigs, divided over three feeding levels (60, 75 and 100% of ad libitum) were tested and dissected. PD was estimated from dissection data using equations developed from a sample of 309 chemically analyzed pigs. Averaged over genotypes and sexes, estimated PD_{max} was 129, 138 and 100 g/d for the three weight ranges respectively, while the corresponding FI_o's were 1.56, 2.20 and 2.29 kg/d. In general FIC was not much different from FI_o. However, gilts from the end product genotypes tended to show a lower FIC than their FI_o, particularly from 25-65 and from 95-125 kg. Because selection for production traits in the purebred lines should be aimed at improving the end product genotypes, it seems beneficial to select for a higher FIC in combination with selection for other traits, especially in sow lines.

Key Words: Feed intake capacity of growing pigs, Optimum feed intake, Protein deposition

276 A canonical correlation analysis of production traits in Large White swine. Z. B. Johnson^{*1} and R. A. Nugent, III², ¹University of Arkansas, Fayetteville, ²The Pork Group, Rogers, AR.

A canonical correlation analysis was used to examine relationships between easily measured (EM) production traits and traits not so easily measured (NEM) for purebred Large White boars. Data were performance test records of 7,529 boars collected in a commercial swine operation from 1990 to 1997. Boars were individually pen tested for approximately 77 days (100 to 177 d of age). They were weighed at the beginning (WT100) and end of the test (WT177) and feed intake recorded. Daily feed intake (DFI) and feed:gain ratio (FG) were computed. Backfat (BF) and loin eye area (LEA) were measured at the 10th rib at the end of the test by ultrasound. Body length (LEN) was measured at this time. The traits WT100, DFI, and FG were adjusted to a beginning age of 100 d using regression coefficients obtained from previous analyses. Likewise WT177, BF, LEA, and LEN were adjusted to an ending age of 177 d. For the canonical correlation analysis, WT100, WT177, and LEN were one set of measurements (EM traits) and DFI, FG, BF, and LEA were the second set of measurements (NEM traits). Three canonical correlations were obtained (.96, .41, and .15; P < .01). Canonical variate 1 was most correlated to WT177 (.90) in the EM set and to DFI (.70) in the NEM set of traits indicating that a major portion of the variation observed contrasted heavier boars that ate more with lighter boars that ate less. Canonical variate 2 was most correlated to WT100 (.95) in the EM set and to FG (.73) in the NEM set of traits. Thus selecting for high values of this variate would choose boars that were heavier at 100 days and had poorer FG values. Canonical variate 3 was most correlated with LEN (-.70) in the EM set and to BF (.82) in the NEM set; therefore, selecting for high values of this variate would select shorter, fatter boars and selecting for low values of this variate would select for longer, leaner boars. Results of this analysis indicate strong relationships between the EM and NEM traits that may useful to producers in selection programs.

Key Words: Pigs, Body Length, Production Traits

277 Estimation of genetic effects for semen quality and quantity in AI boars. S. H. Oh^{*1}, M. T. See¹, and R. Nugent², ¹North Carolina State University, Raleigh, ²The Pork Group - Tyson Foods Inc., Rogers, AR.

The objective of this study is to estimate (co)variances and heritabilities for boar semen traits of motility, morphology and volume. Currently boars selected as "AI quality" are indexed and selected strictly on performance and carcass characteristics. By improving the accuracy of selection of AI sires using the amount and quality of semen it may be possible to reduce the numbers of boars required to service sows and improve overall productivity and profitability. The data of 23,970 animals and 306 AI boars were used to estimate genetic parameters and environmental effects of performance. For each trait, parameters were estimated from an animal model using MTDFREML procedures. Semen volume was described as the number of doses prepared from each ejaculate and motility and morphology scores were visually assigned by the processing technician. The analysis model included season, collector, age and number of collections as fixed effects and the random animal effect. The results obtained in this study are summarized as follows. Genetic variance components are 22.06 for volume, 0.30 for motility and 0.30 for morphology. In phenotypic variances, these are 53.36, 7.81, and 6.00, respectively. The heritabilities estimated from the variance components were 0.41 for volume, 0.04 for motility and 0.05 for morphology. These results would indicate that there is an opportunity to genetically select for increased semen volume but expected response to selection for improved semen motility and morphology would be less. The lower heritability for semen motility and morphology may be due in part to the subjective scores assigned by the processing technicians.

Key Words: semen, heritability, pigs

278 Genetic parameter estimates for real-time ultrasound traits obtained from a multi-breed sheep population. T. Fernandes*, J.W. Wilton, and J.J. Tosh, *Centre for Genetic Improvement of Livestock, University of Guelph, Ontario.*

Variance components were estimated for three ultrasonic traits: loin depth (LD), loin width (LW), and average backfat thickness (AVFAT). Data were collected from purebred and crossbred flocks across Ontario between 1997 and 1999 (n=3483) using the Ultra Scan 50 (Alliance Medical, St. Laurent, Quebec). The population was comprised of 13 breeds (Rideau-Arcott, Canadian-Arcott, Suffolk, Texel, Polled Dorset, Hampshire, Newfoundland, Rambouillet, North-Country Cheviott, Charolais, Shropshire, Oxford, and Border Leicester). The data were analysed with a REML procedure in a multiple-trait animal model. Analyses of all traits included the additive genetic effect of lamb, sex, contemporary group, and breed-group. Covariates of either weight or age were included in two separate analyses. Direct additive heritabilities of 0.29, 0.26, and 0.29 were obtained for loin depth (LD), loin width (LW), and average backfat thickness (AVFAT) respectively, with genetic correlations of 0.43 between LD and LW, -0.17 between LD and AVFAT, and 0.23 between LW and AVFAT. When the data were analysed using age in the regression analysis, direct additive heritabilities were 0.38, 0.30, and 0.35 for LD, LW, and AVFAT respectively. The genetic correlation between traits were all positive, 0.61 between LD and LW, 0.29 between LD and AVFAT, and 0.44 between LW and AVFAT. The genetic variance for all traits was different from zero ($P < 0.05$). Results indicate that it is possible to make genetic improvement if selection is based on ultrasound information.

Key Words: Real-time ultrasound, Genetic parameters, Heritability, Loin depth, Loin width, Backfat thickness, Sheep

279 Preweaning performance of DorperXColumbia, Columbia and SuffolkXWhiteface lambs. H. D. Blackburn*, *USDA-ARS, Ft. Collins, CO.*

The Dorper breed is a new genetic resource that needs evaluation of survival and growth performance in extensive range environments. For two years F1 Dorper-Columbia (DC) lambs were compared to SuffolkXWhiteface [Whiteface ewes were Columbia, Rambouillet or Targhee; (SW)] and Columbia (C) lambs. SAS GLM procedures were used. The mortality model included: year, breed, age of dam and sex as main effects and birth weight as a covariate. Birth weight, average daily gain (ADG) and adjusted 120 d weight (120WT) were evaluated with models that included: year, breed, sex, type of birth or rearing, band,

age of dam and appropriate interactions. Significant breed differences were found for the four traits evaluated and there were no significant interactions between breed and other main effects. Year effects were nonsignificant for birth weight, ADG and 120WT. Significantly lower mortality during the first 20 d of life was found for DC (7.7%) vs. C and SW lambs (12.9 and 15.3%, respectively). Compared to C and SW, DC lambs weighed significantly less at birth (5.2, 5.4 and 4.8 kg, respectively). By 120WT DC were intermediate to C and SW (37.9, 38.4 and 37.1 kg, respectively). For 120WT C were significantly heavier than SW and DC did not differ significantly from either breed. Breed ranking for ADG was C, DC and SW (.276, .269 and .263 kg, respectively) with C having a significantly faster ADG than SW while DC remained intermediate and non-significant. These results indicate the DC may have an advantage in reduced mortality and has no difference for growth characteristics compared to C and SW. The reduction in mortality rate with no difference in growth may infer an increase in bio-economic performance of DC lambs.

Key Words: Dorper, Growth rates, Mortality

280 Investigation of breeding strategies to increase the probability of dog guides attaining optimum size. S. K. Helmink¹, R. D. Shanks^{*1}, and E. A. Leighton², ¹University of Illinois, Urbana, ²The Seeing Eye, Inc., Morristown, NJ.

An optimum-sized dog guide weighs 18 to 32 kg and stands 53 to 64 cm at the withers when mature body size is attained. Effects of directional selection, stabilizing selection, negative assortative mating, selection index with and without restrictions, and independent trait selection were modeled using data from German Shepherd Dogs (GS) and Labrador Retrievers (LR) raised by The Seeing Eye, Inc., Morristown, NJ from 1979 to 1997. The goal of selection was to decrease mature weight and height in GS and decrease mature weight and increase height in LR. Mature weights were recorded for 1333 GS offspring and their 69 dams and 17 sires, and 1081 LR offspring and their 51 dams and 13 sires. Heights were also recorded for offspring and parents, including 871 GS from 70 dams and 15 sires, and 793 LR from 40 dams and 13 sires. Response to selection for one generation of directional selection for a single trait included a 0.50 kg decrease in mature weight for GS, a 0.59 kg decrease in mature weight for LR, a 0.18 cm decrease in height for GS and a 0.91 cm increase in height for LR. Selecting on mature weight alone produced the highest aggregate genetic-economic gain for GS compared to the selection indices, generating a decrease of 2.10 kg in mature weight and a correlated decrease of 0.36 cm in height. In LR, selecting for height alone produced the highest aggregate genetic-economic gain, but caused an increase in mature weight. Weighting the two traits equally but in the opposite direction without restrictions was the only index that produced the desired effect of decreasing weight and increasing height in LR. Increasing the percentage of dogs attaining optimum size may decrease cost of production for The Seeing Eye because fewer dogs would need to be raised and trained to provide assistance to the same number of blind individuals.

Key Words: Body Weight, Height, Selection

281 Genetic parameters for milk yield in Saanen, French Alpine, La Mancha, Toggenburg, and Nubian goats in a dairy goat herd north west of Mexico. A. P. Márquez^{*1}, J. H. Herrera², A. Correa¹, F. J. Verdugo¹, H. C. Hernández³, and H. G. González¹, ¹Universidad Autonoma de Baja California, ²Colegio de Postgraduados, ³Universidad Autonoma de Baja California Sur, Mexico.

Genetic parameters for milk yield were estimated. Data came from an experiment to characterize germplasm from different breeds of goats at northwest of Mexico. A total of 39 pair mother-daughter records were included. Data was analyzed by using least squares. The model (including relationships mother-daughter) consisted of fixed effects of breed group, year of birth and age of dam with date of birth included as a covariate to adjust a common age as well as random effects of animal's genetic value. The milk yield averages in two complete lactations evaluated was: 826.43 \pm 38.20, 806.66 \pm 44.00, 679.61 \pm 48.00, 821.79 \pm 39.00, and 775.45 \pm 43.00 kg to Saanen, French Alpine, La Mancha, Toggenburg and Nubian, respectively. Lactations ranged from 273 to 305d and standardized to 305d. The heritability values for milk yield were ($h^2 = 0.39 \pm 0.12$), and the repeatability values for the same trait ($R = 0.68$

±0.19) respectively. These results based in limited numbers suggest by themselves genetic differences in milk production among breeds.

Key Words: Milk yield, Heritability, Repeatability

282 Environmental factors affecting the racing time of Thoroughbred horses in Brazil. M. Mota, R. Taveira*, and H. Oliveira, *Universidade Estadual Paulista, Sao Paulo, Brazil.*

The aim of this paper was to study environmental factors that affect the racing time of Thoroughbred horses that won races in the classical calendar at the Cidade Jardim race track, Sao Paulo, Brazil. The data used in this study were provided by the Study Book from the Association of Race Horse Breeders (ABCCC). Data included 2000 finishing times from 1110 animals that won 106 different kinds of races held from 1974 to 1998. The analyses were conducted using the GLM procedure of the Statistical Analyses Systems (SAS,1996). Race year, track condition, grade, condition (sex and age combination) and distance were considered as fixed effects in the linear model. Light turf racing track, condition for 3 and 4 year old gelding and horse, and grade I racecourse (GP group I - considered the most important race), provided the best times. The worst times were on drenched turf track, with 2 years old males and in semiclassical races. Linear regression of time on year of race showed an annual decrease of 0.0785 seconds (approximately 2 seconds in 25 years studied). This result is probably due to improvements in nutritional, veterinary, and training aspects, in addition to correlated response to selection (p.e. earnings, rank at the final race) since time is not a trait selected for by the Brazilian Thoroughbred breeders. The quadratic regression of time on distance showed increases in average speed of 0.75 m/s, when racing distance goes from 1000 m (16.80 m/s) to 2000 m (16.05 m/s), and 0.47 m/s from 2000 m to 3000 m (15.58 m/s).

Key Words: horse, race, time

283 Optimization of pig breeding programs by implementing the Optimal Genetic Contribution Theory. E.H.A.T. Hanenberg*¹ and J.W.M. Merks¹, ¹IPG, *Institute for Pig Genetics BV, The Netherlands.*

Commercial pig breeding programmes are mainly focussed on genetic gain. In the present Dutch breeding programmes different methods are used to restrict the rate of inbreeding. A new method was derived by Meuwissen (JAS, 1997) to optimise genetic gain on a restricted level of inbreeding (OGC-theory). The objective of this study was to evaluate the realised inbreeding rates in different commercial breeding lines over the last decade and to study the possibilities for implementation of the new OGC-theory into the breeding programmes. Breeding lines included in this study varied from 100 to 5.000 sows. The number of boars used per generation varied from 29 to 80. The rate of inbreeding, calculated over the last decade, varied from 0.15% to 0.43% per year. Generation intervals varied from 1.5 to 2.3 years. Inbreeding levels per generation varied from 0.31% to 0.89%. In comparison with studies in other breeds inbreeding levels were relatively low. With the OGC-theory optimal contributions of male and female selection candidates to the next generation can be calculated. Information needed is limited to estimated breeding values of, and relationships between selection candidates and a predefined desired maximum rate of inbreeding. In this study the OGC-theory was implemented for male selection only for two selection moments: (1) selection of boars after own-performance-testing and (2) culling of AI-boars which have reached there optimal contribution. Change of the culling strategy of AI-boars from a fixed amount of inseminations per boar to a variable amount of inseminations based on the OGC-theory gave a 10% to 20% higher genetic improvement under an equal rate of inbreeding. The OGC-theory can also be implemented for female selection and for selection of testing candidates for an optimal use of testing capacity. It is concluded that rates of inbreeding are relatively low in commercial pig breeding programmes. Application of the OGC-theory will improve genetic progress with at least 10 to 20% under restriction of the same level of inbreeding.

Key Words: Inbreeding, Pigs, Selection Methods

284 Direct and correlated responses to selection for ovulation rate or uterine capacity in swine. K. A. Leymaster* and R. K. Christenson, *USDA-ARS; U.S. Meat Animal Research Center; Clay Center, NE.*

The objective was to estimate responses of ovulation rate (OR), uterine capacity (UC), and litter size (LS) to selection for either OR or UC in a four-breed composite population of swine. A replicate of each OR, UC, and control (CO) line was established in two seasons (A and B). During the selection phase of the experiment, OR at the estrus of conception was recorded on dams of line OR. In line UC, UC per uterine horn was measured as number of fully-formed pigs born to unilaterally hysterectomized-ovariectomized (UHO) dams. Boars and gilts from OR and UC dams with the greatest records were selected for 11 generations. Then, to remove accumulated inbreeding effects prior to evaluation of responses, generation 11 replicate A gilts were mated to generation 10 replicate B boars and generation 11 replicate B gilts to generation 11 replicate A boars. Resulting littermate gilts of each line were randomly assigned to either remain intact for observation of OR and LS or to undergo UHO surgery for observation of OR and UC. At least 134, 62, and 62 observations for OR, UC, and LS, respectively, were collected within each line. Responses to selection were estimated as differences between means of selected and control lines and SE of differences included terms for drift variance. Direct selection for OR was effective (3.21 ova, $P < .001$), however, correlated responses in UC (-11 pigs per uterine horn) and LS (.70 pigs) were not detected. Likewise, direct selection for UC increased UC by 1.11 pigs per uterine horn ($P < .01$), although correlated responses in OR (-.01 ova) and LS (.92 pigs) were not detected. These responses established that OR and UC were heritable and genetically independent of one another. Using published equations based on the OR-UC model of LS, observed and predicted LS means were 10.62 and 10.50 pigs for line CO, 11.32 and 11.69 pigs for line OR, and 11.54 and 11.04 pigs for line UC. Simultaneous increases in both OR and UC are necessary to produce a substantial increase in LS.

Key Words: Swine, Selection Responses, Reproductive Traits

285 Bayesian analysis of lifetime performance and prolificacy in Landrace sows using a linear mixed model with censoring. S. Guo*¹, D. Gianola¹, and T. Short², ¹University of Wisconsin-Madison, ²PIC USA.

Factors affecting variation of length of productive life (LPL), and lifetime prolificacy (LTP) in Landrace sows were investigated. Data were herd life and prolificacy records from 2616 daughters of 343 sires born in a nucleus herd between 1990 and 1996. Records from sows sold to other farms for production were treated as censored. Factors studied were year-season of entry in the breeding herd, age at herd entry, litter size at first parity (for LPL) and sire of the sow. Additional censoring rates of 25% and 35% were created to assess influence of censoring on fixed effects, variance components and sire evaluation. LPL, log(LPL) and LTP were analyzed using a linear mixed model with censoring. Age of entry into the breeding herd did not affect the traits studied. Sows with smaller litters at first parity had a higher risk of being culled than more prolific gilts. Posterior means of heritability of LTP, LPL and log-LPL were 0.22-0.25. Intra-trait correlations between sire evaluations at the 3 censoring rates ranged between 0.69 and 0.96. The rank correlation between sire evaluations for LPL and LTP (actual data set) was 0.85, suggesting a strong genetic correlation. Estimates of sire effects with censored records removed from the analysis were in less agreement with evaluations obtained with the actual data set than those found with the artificial censoring rates.

Key Words: Herd-life, Linear model, Swine

286 Genetic parameter estimates from joint evaluation of purebreds and crossbreds in swine. E. Lutaaya¹, I. Misztal*¹, J. W. Mabry¹, T. Short², H. H. Timm², and R. Holzabauer², ¹University of Georgia, Athens, ²PIC USA, Franklin, KY.

Data on two purebred lines A (n = 6,022), B (n = 24,170), and their reciprocal cross C (n = 6,135) obtained from a commercial swine company was used to estimate genetic parameters using a crossbred model of Lo, Fernando, and Grossman. Genetic parameters were also estimated from within lines, as a check on procedure. The traits investigated were lifetime daily gain (LDG) and backfat. The models fitted included fixed (contemporary group and sex), random additive, random dominance,

and random litter effects. For backfat, end weight was included as a covariable and the dominance effect was not fitted. Heritability estimates for LDG were .26, .29, and .23 for lines A, B, and C respectively, for within line models and .26, .30, and .29 for the crossbred model. For backfat the heritability estimates were .53, .38, and .27 from within line and .51, .38, and .32 from the crossbred model, for lines A, B, and C, respectively. Similarity of heritabilities across lines suggests that purebred and F1 data can be combined to improve accuracy of parameter estimates. The genetic correlations between purebreds and crossbreds (r_{pc}) for LDG were .62 (A-C), .80 (B-C); for backfat the r_{pc} estimates were .75 (A-C) and .71 (B-C). The estimated genetic correlations were $\leq .8$ suggesting a possible benefit from combined evaluation of purebreds and crossbreds. The amount of dominance variance from the crossbred model expressed as a proportion of phenotypic variance for LDG was .21, .14, and .17 for lines A, B, and C, respectively. These estimates suggest mating systems can be designed to exploit non-additive genetic variation for LDG.

Key Words: Key Words: Multibreed Evaluation, Genetic Correlation, Crossbreds

287 Joint evaluation of purebreds and crossbreds in swine: II. animal rankings. E. Lutaaya¹, I. Misztal*¹, J. W. Mabry¹, T. Short², H. H. Timm², and R. Holzabauer², ¹University of Georgia, Athens, ²PIC USA, Franklin, KY.

Data from two purebred swine lines A (n = 6,022), B (n = 24,170), and their reciprocal cross C (n = 6,135) was used to examine the gains in accuracy of combined purebred and crossbred evaluation using the crossbred model of Lo, Fernando, and Grossman over conventional within line evaluations. A second objective was to compare animal rankings from within line, approximate, and crossbred model evaluations. The traits in the evaluation were lifetime daily gain (LDG) and backfat. The gains in mean accuracy of predicted purebred breeding values for both traits ranged from 2 to 9% when crossbred information was included in evaluations using the crossbred model. Gains in mean accuracy of predicted breeding values of purebreds for crossbred performance ranged from 21 to 72% when crossbred data was used in genetic evaluations. Rank correlations of predicted breeding values from within line and crossbred models were high ($> .99$) for the purebreds, but were lower ($\leq .87$) for crossbreds. Rank correlations of predicted breeding values from approximate and crossbred models were high ($\geq .96$) and suggest that where variances are similar across lines, the approximate model can be used for genetic evaluation. It is concluded that the gains in accuracy of predicted purebred breeding values will be small with limited crossbred information. However, if the breeding goal is crossbred improvement, the gains in accuracy of predicted breeding values of purebreds for crossbred performance are substantial and warrant joint evaluation of purebreds and crossbreds, even with small amounts of crossbred data.

Key Words: Key Words: Multibreed Evaluation, Accuracy, Crossbreds

288 Effects of recombination on weight from birth to 154 days of age in pigs. J. P. Cassady* and K. A. Leymaster, USDA-ARS; U.S. Meat Animal Research Center; Clay Center, NE.

The objective was to determine the influence of nonadditive gene action on pig growth in two experiments. Experiment 1 (Exp1) included Yorkshire, Landrace, Large White, and Chester White pigs. Experiment 2 (Exp2) included Duroc, Hampshire, Pietrain, and Spot pigs. Data were recorded on purebred, two breed, and F₁ through F₆ generations, where F₁ pigs are the first generation of a four-breed cross. Pig weights were recorded at birth, 14, 28, 56, 70, 98, 126, and 154 d of age. Number of observations at birth and 154 d of age were 7,685 and 4,351 in Exp1 and 7,159 and 3,996 in Exp2, respectively. Data from each experiment were analyzed separately. A mixed-model analysis was done with fixed effects of year and sex and random effect of sire within year. Included as covariates in each model were effects of direct and maternal heterosis and an effect due to recombination in crossbred animals, which is the breakdown of epistatic effects present in purebreds. Models also included direct, maternal, and grandmaternal effects of each breed as covariates. Effects of direct heterosis increased ($P < .1$) weights at all ages in both experiments. In Exp1 effects due to recombination were negative ($P < .1$) for birth weight and positive ($P < .1$) for weight at 98 and 126 d of age. In Exp2 effects due to recombination were positive ($P < .1$) for weights at birth, 14, and 28 d of age. Recombination effects did influence pig weights at early ages in both experiments. Epistasis

affects early pig growth and thus, may indirectly affect pig viability. Effects of recombination on birth weight were in opposite directions in the two experiments. Advances in molecular techniques may allow for selection of favorable epistatic effects.

Key Words: Pigs, Growth, Epistasis

289 Predicting feed efficiency from associated traits in Duroc pigs selected for lean growth efficiency. D. L. Kuhlers*, K. Nadarajah, and B. L. Anderson, Auburn University, AL.

Efficiency of feed utilization is an important economic concern in swine production but gathering individual feed consumption data for performance testing is a very expensive process. The objective of this study was to determine whether it is necessary to directly measure feed efficiency rather than only predicting it from genetic relationships with ultrasound backfat thickness (UBF) and 168 day weight (AWT168). The data used for this study were from six generations of selection in a line of Duroc pigs selected on an index giving equal weights to EBVs for UBF and predicted feed conversion (PFC) with a contemporary control line. In each generation, up to 40 randomly selected barrows from both lines (n=200, over six generations) were placed in individual pens at 35 kg BW and fed ad lib until they reached 105 kg BW. Information on feed intake, AWT168, F/G, days on feed (DOF) and real-time UBF at 10th rib were obtained. Performance of gilts and boars from both lines for 168d wt and UBF were also recorded. Data were analyzed using a multiple trait mixed model program (MTDFREML) applying genetic and residual (co)variances estimated from the data that included F/G on barrows to obtain EBVs for AWT168, UBF and F/G. The correlation between EBVs for PFC used in the selection index and EBVs computed for F/G from MTDFREML on 200 barrows was 0.93 ($P < 0.001$). Compared to the control line pigs, the mean EBVs of select line pigs in the 6th generation showed a reduction in UBF by 0.71 cm and 23 kg less feed/100 kg of gain. A linear prediction of EBVs for F/G of barrows on test ($R^2=0.77$) showed significant influence of UBF ($P < 0.001$), AWT168 ($P < 0.01$) and DOF ($P < 0.05$) whereas the actual individual F/G of barrows showed little influence ($P=0.18$) in predicting EBVs for feed efficiency. Correlation between EBVs for UBF and EBVs for F/G among the barrows was 0.89 ($P < 0.001$), and a partial regression analysis (STEPWISE) indicated that UBF ($R^2=0.61$) had the largest single influence on F/G in pigs. It appears that direct measurement of F/G performance data contributes little to that already explained by UBF and AWT168.

Key Words: Pigs, Selection, Feed Efficiency

290 Effect of IMF-level as affected by genotype, sex, slaughter weight and feeding level on pork quality and consumers' perception. J.W.M. Merks*¹, P. Walstra², and E. Kanis³, ¹IPG, Institute for Pig Genetics B.V., Beuningen, The Netherlands, ²Institute for Animal Science and Health, ID-Lelystad, The Netherlands, ³Wageningen Institute of Animal Sciences, Wageningen University, The Netherlands.

To test the effects of genotype (2 crossbred commercial types), sex (gilts and barrows), feeding level (ad libitum and restricted feeding) and slaughter weight (95 and 125 kg) on intramuscular fat percentage (IMF) in the loin meat and its consumers' appreciation, an experiment was set up with in total 470 pigs. Pigs were housed in groups of 8 per pen of only one genotype, sex and feeding level. All pigs in the pen were slaughtered when the average weight of 95 or 125 kg was reached. At 24 hours after slaughtering, carcasses were dissected into wholesale joints and measurements of pH and colour were taken. About 10 cm of the loin, next to the transition of ham and loin, of the left carcass half was used to measure drip loss and intramuscular fat (IMF). From in total 96 carcasses the left and right loin was classified according to level of IMF and used in a consumer test. In total 256 consumers were asked to give their opinion on various sensoric characteristics of 4 pieces of grilled loin. Statistical analyses showed significant ($P < 0.05$) effects of genotype, sex, slaughter weight and feeding level on IMF and pH. Drip loss and colour were only significantly affected by genotype and feeding level. The consumer appreciation test showed that variation in IMF had a significant effect on taste (especially for the characteristic 'real pork taste'), juiciness, tenderness and overall appreciation. Especially the low levels of IMF were evaluated as negative. Besides the level of IMF, the consumers' appreciation was affected by effects of genotype and feeding level but not by sex or weight. From these results it is concluded that

the level of intramuscular fat is an important quality characteristic of pork which can be regulated by choice of genotype and feeding level during fattening. Especially low levels of IMF (below 1%) are a risk for the overall appreciation of pork.

Key Words: Intramuscular fat, Pork quality, Consumers' perception

291 Impact of measurement errors on predicting pork carcass composition. I. Within-sample evaluation. D.L. Lofgren*, A.P. Schinckel, and T.S. Stewart, *Purdue University, West Lafayette, IN.*

Data were simulated for carcass weight (CW, mean=84 kg), fat depth (FD, mean=25 mm) and muscle depth (MD, mean=50 mm). Fat-free lean mass (FFLM, mean=38 kg) was calculated as $FFLM = 4.64 + .459 \cdot CW - .442 \cdot FD + .117 \cdot MD + eij$, where eij was a random deviation for the pig. Measurement errors for FD and MD were simulated for each pig: the deviation from the mean for FD and MD was reduced by 85, 70 and 55%, which reduced the covariance with FFLM; random error was added to maintain the level of variation in FD and MD. Random measurement errors for FD and MD had a correlation of -.50. The simulated data contained 900 lines, with 15 pigs/line from each of two sexes. The lines were divided into nine groups, based on line means for FD and MD. Subsets of the data were created by randomly selecting one line from each of the nine groups; 50 subsets were randomly chosen for analysis. Equations to predict FFLM from CW, FD and MD were derived for each subset. As the level of simulated measurement error increased, the R^2 of the prediction equations decreased, residual standard error increased, the intercept increased, and regression coefficients for CW, FD and MD became closer to zero. All of these statistics became more variable, and individual equations for a subset were very different. As errors increased, line and sex biases were seen, particularly with 70 and 55% measurement errors. Correlations between line means for actual and predicted FFLM decreased as errors increased. The equations were less able to detect true differences between lines and between sexes as measurement errors increased. Variance ratios (variance of predicted line means divided by variance in actual line means) averaged 1.00 for data without errors, and decreased to .55, .32 and .20 as measurement errors increased. Predicted differences between the sexes were 99% of the actual difference for data without errors, and decreased to 69, 46 and 30% as measurement errors increased.

Key Words: Measurement Errors, Pork, Carcass Composition

292 Impact of measurement errors on predicting pork carcass composition. II. Out-of-sample evaluation. D.L. Lofgren, A.P. Schinckel, and T.S. Stewart*, *Purdue University, West Lafayette, IN.*

Data were simulated for carcass weight (CW), fat depth (FD) and muscle depth (MD). Fat-free lean mass (FFLM) was calculated. Measurement errors were simulated for each pig: the deviation from the mean for FD and MD was reduced by 85, 70 and 55%, which reduced the covariance with FFLM; random error was added to maintain the level of variation in FD and MD. Fifty subsets of nine lines, with 15 pigs/line from each of two sexes, were simulated. Prediction equations for FFLM were derived for each subset. A large dataset of slaughter pigs was simulated for an out-of-sample analysis to evaluate the efficacy of derived prediction equations. This had 40 lines, and 80 pigs/line for each of two sexes. Measurement errors were simulated for these pigs as they were for the estimation data. When the equations were developed using data without errors, and the slaughter pig data being evaluated was without errors, correlations between actual and predicted line means were .99, variance ratios (VR; variance of predicted line means divided by variance of actual line means) were close to 1, and the predicted difference between the sexes was 98% of the actual difference. With any measurement error, either in development of equations or in slaughter pig data evaluated, there were significant line and sex biases. Correlations between actual and predicted line means were high ($r > .81$). However, the equations were unable to predict the true line or sex differences. VR decreased approximately 30% with each increase in error level (in equation or pig data), so that with the highest level of errors, VR averaged .11. Sex differences decreased similarly, and predicted differences were 26% of actual differences when errors were highest. For a given level of measurement error in slaughter pig data, equations based on data with the least measurement error produced the least biases. Increased

measurement error in the data used for equation development resulted in increased out-of-sample line and sex biases.

Key Words: Measurement Errors, Pork, Carcass Composition

293 Prediction of kilograms of boneless primal yield and standardized primal cuts in pigs. H. Sellers*¹, T. J. Baas², and R. N. Goodwin¹, ¹National Pork Producers Council, Ames, IA, ²Iowa State University, Ames.

Data from the National Pork Producers Council (NPPC) Quality Lean Growth Modeling project were used to develop prediction equations for estimation of the components of boneless primal yield (BPY) and total BPY, and standard primal cuts (SPY) and total SPY. Pigs representing six genetic types, four diet regimes, two sexes, three off test weight groups, and three test groups were included. Genetic types were chosen to represent high, medium, and low attributes of growth, feed intake, backfat, and meat quality. Pigs were evaluated with real-time ultrasound (SCAN) one week prior to slaughter at Quality Pork Processors in Austin, MN, where they were evaluated using four procedures: Fat-O-Meater developed by SFK Technologies (FOM); Carcass Value Technology system developed by Animal Ultrasound Services, Inc. (AUS); last rib midline ruler (RUL); and carcass measurement (CARC). Dissection data from 699 half carcasses were used and primals were cut according to the IMPS references. BPY is the sum of the following cuts: inside ham, outside ham, knuckle ham, loin, shoulder, belly, and spare ribs. SPY is the sum of Ham401, Loin410, Picnic405, Boston Butt406, Belly409, and Spare Ribs416. Prediction equations were developed for each cut and for total kilograms of lean. Model fixed effects were genetic type, diet, sex, and off test weight group. Model R^2 values ranged from .908 to .959 for SPY and .831 to .891 for BPY. The range in R^2 values for prediction equations for components of SPY was small. Best fitting equations for components of BPY were for FOM, CARC, and SCAN.

Key Words: Pigs, Prediction, Primal yield

294 Correlations among methods of estimation of kilograms of lean in pigs. T. J. Baas*¹, H. Sellers², and R. N. Goodwin², ¹Iowa State University, Ames, ²National Pork Producers Council, Ames, IA.

Data from the National Pork Producers Council (NPPC) Quality Lean Growth Modeling project were analyzed to determine correlations among four methods for estimation of kilograms of lean. Pigs representing six genetic types, four diet regimes, two sexes, three off test weight groups, and three test groups were included. Genetic types were chosen to represent high, medium, and low attributes of growth, feed intake, backfat, and meat quality. Pigs were slaughtered at Quality Pork Processors in Austin, MN, and evaluated using four evaluation procedures: Fat-O-Meater developed by SFK Technologies (FOM); Carcass Value Technology system developed by Animal Ultrasound Services, Inc. (AUS); last rib midline ruler (RUL); and carcass measurement (CARC). Dissection data from 699 half carcasses cut according to IMPS references were used to develop prediction equations for kilograms of standardized lean (SDLN), kilograms of standardized fat-free lean corrected for moisture content (FFLN), kilograms of boneless primal cuts (BLSP), and kilograms of standard primal cuts (SDSP). Model fixed effects were genetic type, diet, sex, and off test weight group. Ranges in Pearson correlation coefficients across the four prediction methods were: .857 to .994 (FOM); .933 to .996 (AUS); .927 to .997 (RUL); .831 to .993 (CARC). Prediction of SDLN was highly correlated to FFLN (FOM, .993; AUS, .996; RUL, .997; CARC, .993). Prediction of BLSP was highly correlated to SDSP (FOM, .994; AUS, .995; RUL, .997; CARC, .991). A strong relationship exists among the four prediction methods evaluated.

Key Words: Pigs, Lean, Prediction

295 Genetic parameter estimates for prolificacy, growth and fleece characteristics of Targhee sheep. K. J. Hanford*¹, G. D. Snowder², and L. D. Van Vleck³, ¹University of Nebraska, Lincoln, ²USDA, ARS, US Sheep Experimental Station, Dubois, ID, ³USDA, ARS, US Meat Animal Research Center, Lincoln, NE.

Heritabilities and genetic correlations for prolificacy, growth and fleece traits were estimated from Targhee data collected from 1950 to 1998. Number of records ranged from 33,978 to 38,625, 32,715 to 33,994, 3,341

to 36,807 for prolificacy, growth and fleece traits. Direct heritability estimates from single trait animal model analyses using REML were .10 for number lambs born (NB), .07 for number lambs weaned (NW), .10 for litter weight at weaning (LW), .25 for birth weight (BW), .22 for 120 d weight (WW), .41 for fleece grade (FG), .54 for fleece weight (FW) and .65 for staple length (SL). Maternal heritability estimates were .20 for BW and .11 for WW. Estimates of genetic correlations among prolificacy traits were positive (.77 for NB-NW, .72 for NB-LW, .94 for NW-LW). Between BW and WW both the direct and maternal genetic correlations were positive (.52 for direct and .35 for maternal). FG was negatively correlated with both FW (-.47) and SL (-.69), and FW was positively correlated with SL (.54). Estimates of genetic correlations were small between the prolificacy and growth traits, except for the correlation between LW and WW, which was moderately correlated (.00, .00, .18, .20, .15, .38 for NB-BW, NW-BW, LW-BW, NB-WW, NW-WW and LW-WW). Estimates of genetic correlations were small between fleece characteristics and prolificacy traits: for FW (-.19, -.19, .04), for FG (.09, .11, .00) and for SL (-.14, .05, .09) with NB, NW and LW, respectively. Growth traits were positively correlated with FW and SL (.24, .24, .10, .08 for BW-FW, WW-FW, BW-SL and WW-SL), and negatively correlated with FG (-.06, -.05 for BW and WW).

Key Words: Heritabilities, Genetic Correlations

296 Genetic parameter estimates for prolificacy, growth and fleece characteristics of Columbia sheep. K. J. Hanford*¹, G. D. Snowder², and L. D. Van Vleck³, ¹University of Nebraska, Lincoln, ²USDA, ARS, US Sheep Experimental Station, Dubois, ID, ³USDA, ARS, US Meat Animal Research Center, Lincoln, NE.

Heritabilities and genetic correlations for prolificacy, growth and fleece traits were estimated from Columbia data collected from 1950 to 1998. Number of records ranged from 27,009 to 31,401, 23,903 to 24,741, 2,449 to 29,572 for prolificacy, growth and fleece traits. Direct heritability estimates from single trait animal model analyses using REML were .09 for number lambs born (NB), .06 for number lambs weaned (NW), .07 for litter weight at weaning (LW), .27 for birth weight (BW), .16 for 120 d weight (WW), .41 for fleece grade (FG), .53 for fleece weight (FW) and .55 for staple length (SL). Maternal heritability estimates were .25 for BW and .08 for WW. Estimates of genetic correlations among prolificacy traits were positive (.84 for NB-NW, .79 for NB-LW, .94 for NW-LW). Between BW and WW both the direct and maternal genetic correlations were positive (.56 for direct and .58 for maternal). FG was negatively correlated with both FW (-.47) and SL (-.70); FW was positively correlated with SL (.55). Estimates of genetic correlations were low between BW and the prolificacy traits (.10, .00, .11 for NB, NW, and LW) and moderate between WW and the prolificacy traits (.33, .24, .73 for NB, NW, and LW). Estimated genetic correlations were small between fleece characteristics and prolificacy traits: for FW (-.13, -.14, .08), for FG (.17, .04, .00) and for SL (-.05, -.20, -.05) with NB, NW and LW, respectively. Growth traits were positively correlated with FW (.21, .18 for BW and WW); negatively correlated with FG (-.04, -.11 for BW and WW) and SL was positively correlated with BW (.05) and negatively correlated with WW (-.04).

Key Words: Heritabilities, Genetic Correlations

297 Genetic parameter estimates for growth characteristics in a local sheep flock in United Arab Emirates. S. Al-Shorepy*¹, United Arab Emirates University, Al Ain, United Arab Emirates.

Variance and covariance components and associated genetic parameters were estimated for lamb birth weight (BWT), daily gain from birth to weaning (ADG) and weaning weights (WWT) using REML procedures and single- and two-trait animal models. Data in this study were the accumulated records over the years 1994 to 1999 obtained from the Faculty of Agricultural Sciences Experimental Station, United Arab Emirates. It consisted of weight registrations of local purebred and of crossbred (>87% local purebred) lambs. The analytical model included fixed effects of sex, year-season, type of rearing and (for the combined data set) breed. The most complete model also contained random additive, additive maternal, permanent environmental maternal and residual effects. The analyses were conducted for the three data sets. Estimates of additive direct, additive maternal, and permanent environmental maternal effects, respectively, as a proportion of phenotypic variance for

combined data were .30, .19, .03 (BWT); .44, .04, .01 (ADG), and .40, .03, .01 (WWT). Estimates of genetic correlations were .25 (BWT with ADG); .46 (BWT with WWT); and .92 (ADG and WWT). Residual correlation estimates ranged from .12 (BWT with ADG) to .96 (ADG and WWT). Correlations between additive maternal effects and permanent environmental maternal effects for BWT and WWT were close to unity. It can be concluded that, additive maternal effects were more important for birth weight trait than for the other two traits. Additive and permanent environmental maternal effects on BWT and WWT were highly correlated, indicating that many of the same genes and factors are involved.

Key Words: Local Sheep, Genetic parameters, Growth traits

298 The genetic components of dietary selection for Mountain Big Sagebrush (*Artemisia tridentata* ssp. *vaseyana*) in Rambouillet sheep. G. D. Snowder*¹, J. W. Walker², K. L. Launchbaugh³, and L. D. Van Vleck⁴, ¹USDA, ARS, U.S. Sheep Experiment Station, Dubois, ID, ²Texas A&M University Agricultural Research and Extension Center, San Angelo, ³University of Idaho, Moscow, ⁴USDA, ARS U.S. Meat Animal Research Center, Lincoln, NE.

The heritability of diet selection for big sagebrush by grazing sheep was estimated from fecal samples from a total of 549 Rambouillet ewes. Fecal samples were collected in September and October during 1996 and 1997 from free-grazing ewes on intermountain sagebrush-bunchgrass rangelands at the U.S. Sheep Experiment Station in Idaho. The total number of fecal samples was 1,949. Fecal samples were evaluated for composition of big sagebrush by near-infrared spectroscopy. Big sagebrush consumption was less in September than October (21.6 vs 31.7%, respectively). Single trait and bivariate derivative-free REML analyses were performed to genetically compare big sagebrush consumption between September and October. Heritability estimates were similar between September and October sampling (.25 and .28, respectively). The genetic correlation between September and October diet preference was high ($r_G = .91$), inferring that there is a strong genetic similarity between September and October measurements. These results contribute to a greater understanding of dietary preferences in free grazing sheep, and suggest opportunities to improve production efficiency and forage management through selection for dietary preferences.

Key Words: Diet Selection, Sheep, Grazing

299 Heritability estimates for electrical conductivity of milk and correlations with predicted transmitting abilities for somatic cell scores. R.C. Goodling*¹, G.W. Rogers¹, J.B. Cooper¹, and B. Rune², ¹Pennsylvania State University, University Park, ²SAE Afikim, Kibbutz Afikim, Israel.

Electrical conductivity of milk (EC) increases during mastitis and can be routinely measured during each milking of dairy cattle. The objectives of the study were to estimate heritabilities for EC and to examine the relationship between sire PTASCS and daughter means of EC in various lactation segments. The Afikim computerized milking and management system measures composite EC in millimho (mmho) during milking and records daily averages for EC. Analyses were performed on 3503 cows sired by 259 bulls in eight herds. Heritabilities for EC were determined using the PROC MIXED procedure of SAS[®] with a model that included herd-year-season, age at calving, and sire. Heritabilities for lactation 1 were moderate: 0.36 for the EC mean over the lactation, 0.38 for days in milk (DIM) 6 to 100, 0.39 for DIM 101 to 200, and 0.27 for DIM 201 to 365. Heritabilities for EC for lactation 2 were also moderate: 0.22 for the mean over the lactation, 0.22 for DIM 6 to 100, 0.23 for DIM 101 to 200, and 0.21 for DIM 201 to 365. Sire solutions for mean EC over lactations 1 and 2 were correlated with sire PTASCS from USDA; correlations based on sires with 20+ daughters were 0.30 (lactation 1) and 0.46 (lactation 2). In addition, daughter EC was regressed on sire PTASCS. Bulls with higher PTASCS had daughters with significantly higher EC. The positive correlations and moderate heritabilities from this study indicate that EC might be useful in selecting for mastitis resistance in dairy cattle.

Key Words: Conductivity of Milk, Heritability, Mastitis Resistance

300 Estimates of genetic parameters for linear type traits, yield traits, and somatic cell scores in Holsteins divergently selected on transmitting ability for type. B. J. DeGroot^{*1}, J. F. Keown¹, and L. D. Van Vleck², ¹University of Nebraska, Lincoln, ²USDA, ARS, US Meat Animal Research Center, Lincoln, NE.

For four generations, half of the university research Holstein herd was bred to Holstein sires with predicted transmitting ability for type (PTAT) > 1.50 and the remainder to sires with PTAT < 1.25, with nearly equal PTA for yield traits for both groups. Data on first lactation cows for 16 linear type traits, final score, and milk, fat, and protein lactation yields were collected from 1986 to 1999 and on somatic cell scores (SCS) from 1992 to 1999. Estimates of heritabilities, genetic correlations, and phenotypic correlations were obtained from REML estimates of (co)variance components. Fixed effects were date cows were classified, age in days at freshening as a linear covariate, and days in lactation at classification as linear and quadratic covariates in model for type and year-season in which a cow freshened in model for yield and SCS. Animal genetic and residual were random effects. Heritability estimates for linear type traits ranged from 0.04 to 0.47. Final score, and milk, fat, and protein yields had heritability estimates of 0.38, 0.13, 0.22 and 0.09, respectively. Heritability estimate of SCS was 0.38. Estimates of genetic correlations among linear type traits ranged from -0.79 to 1.00 and of phenotypic correlations ranged from -0.27 to 0.84. Estimates of genetic correlations of final score with SCS and milk, fat, and protein yields were -0.68, 0.04, -0.16, and 0.10, respectively. Phenotypic correlations of final score with SCS and milk, fat, and protein yields were -0.16, 0.17, 0.10, and 0.22, respectively. The genetic correlation between final score and SCS suggests that selection for increased final score would decrease SCS, whereas, the correlations between final score and yield traits suggests that selection for increased final score would result in little change in yield traits.

Key Words: Genetic Correlations, Heritability, Dairy Cattle

301 Prediction of breeding value for milk, fat and protein yield based on endocrine response profiles. M.K. Soerensen^{*}, P. Madsen, K. Sejrsen, M. Vestergaard, and P. Lovendahl, Danish Institute of Agricultural Sciences, Denmark.

The objective of the study was to relate a number of endocrine variables measured in juvenile cattle to their breeding value for yield. With the view to develop early selection criteria for improved dairy cattle breeding schemes. Dairy bull (N=452) and heifer (N=372) calves from the Danish MOET scheme were tested as juveniles (age 9 month) with a panel of endocrine challenge tests. Prior to testing, calves were fed at maintenance for 7 days and fasted overnight. On the day of testing blood plasma was sampled serially before and following intravenous administration of GRF, adrenaline and glucose. Response to GRF was measured as bovine GH before and following challenge, and as degradation rate. Likewise response to adrenaline was observed in glucose and free fatty acids; and for the glucose tolerance test, as glucose degradation rate, and insulin peak. Most heifers (N=316) from the program stayed in the MOET herd and had at least one lactation there. The data set for milk yield included these heifers plus 816 herd mates. Among the bull calves from the experiment, 142 were progeny tested in Denmark. Daughter yield deviations (DYD) from these bulls and 5200 contemporaries were evaluated. Genetic parameters were estimated using a multivariate animal model. The heritability of GH variables was already high ($h^2=0.76$) in heifers before GRF but low ($h^2=0.10$) in bulls. Following GRF, the heritability was high in both gender groups (heifers $h^2=0.57$, bulls $h^2=0.41$). Also GTT helped increasing heritability of insulin in both sexes. In general genetic correlations between variables measured in bulls and heifers approached unity. Correlations between endocrine variables and yield in the MOET herd and daughter yield deviations were largely in agreement. Based on these parameters it is possible to combine an "endocrine" index with a correlation of 0.42 to yield traits. The experiment confirm that it is possible to speed up genetic progress for yield in advanced dairy nucleus breeding schemes using endocrine response profiles.

Key Words: Endocrine response, Dairy cattle, Genetic parameters

302 Value of bull fertility computed from many states: its effects in single states. B.T. McDaniel^{*}, J.S. Clay, and C.H. Brown, ¹North Carolina State University, Raleigh.

Objectives were to determine how well Estimated Relative Conception Rates (ERCR) computed from 1.4 million records reported by herds in over 30 states predicted non-return rates in lactating Holstein cow mates in various subsets. Bulls with ERCRs higher than 2.9 were coded as High and those lower than -2.9 were Low. Others were denoted as Average. Cow values were adjusted for herd-year, early lactation Energy Corrected Milk (ECM), parity and days in milk when inseminated for the first time. Subsets were cows only in NC and cows only in VA. Both were further subdivided by month bred. In 22 of the 24 subsets cows mated to High bulls had the highest non-return rate. Superiorities averaged 10 units over Low bulls (range 0 to 18) and three units over Average ones (range -2 to 10). Effects of cow ECM were significant but much less than those of mating bulls. Results show that ERCR computed from herds in many areas of the US is useful in predicting non-return rates in herds in a single state-month subclass. Most if not all producers will improve non-return rates of similar cows by breeding them to bulls with High ERCRs while use of Low ERCR bulls will result in lower non-return rates.

Key Words: Bull Fertility, Non-return Rate, Holsteins

303 Genetic parameters of udder, mastitis and milk traits in two different climatic area using animal model analysis. A.A. Amin^{*1} and T. Gere², ¹Suez Canal University, Faculty of Agriculture, Department of Animal Production, Ismailia-Egypt, ²Godollo University of Agriculture Sciences, Gyongyos College of Agriculture.

Lactation records of 2567 Holstein-Friesian (HF) cows in Egypt (sub-tropical area) and Hungary (rainy area) were used to detect any effect of drought on changing genetic parameters. Traits studied were udder length and depth, teat length, attachment and placement and milk production traits (total milk, fat and protein yield). Variation in all studied traits due to random effects of sires groups was much higher in the rainy area than in the subtropical one. Change of all genetic (co)variances with advancing order of lactation were greater for subtropical animals. In subtropical heritability estimates of udder traits for HF were higher than estimates for milk production and the their differences were also higher than the corresponding estimates of cold rainy area. Low heritability estimate was computed for mastitis infection for Hungarian HF. Highest genetic and phenotypic correlation (-0.67 and -0.87, respectively) for mastitis with udder depth were recorded in subtropical area. Many details concerning genetic parameters, which could be taken into consideration during planning and carrying out phenotypic and genetic selection for improving total economic benefit of dairy farms were tabulated and discussed.

Key Words: Udder conformation, Mastitis and milk production, Genetic parameters

304 Studies on genetics of heat tolerance in dairy cattle with reduced weather information via cluster analysis. O. Ravagnolo and I. Misztal, The University of Georgia, Athens.

One of the limiting factors in dairy production in hot climates is heat stress. Under heat, animals produce less and have lower reproduction rates. The genetic components of heat tolerance in Holstein cattle in Georgia were previously studied by combining test data and use of weather information from 21 weather stations throughout the state. The assignment of a weather station to each herd was done manually and was laborious. With data from multiple states, matching herds and weather stations may become even more difficult. The objective of this study was to explore the possibility of reducing the number of weather stations for studies on heat tolerance. Similarity of information from Georgia weather stations was analyzed by cluster analysis. Two major clusters have been found, separating Georgia into North and South along the NE-SW line. One weather station was selected for each of the clusters based on the minimal distance to all the remaining weather stations and completeness of the weather information. The final data set consisted of 114751 first-parity test-day records on 14297 Holsteins from 120 herds in Georgia. Analyses using a model for daily milk yield with temperature humidity index (THI) classes and several other fixed effects showed no increase in Error Sum of Squares when using only two

weather stations. Average daily production was relatively constant at 60 lb. The threshold point at which production started to decline was 72 THI with all weather stations, 72 THI with one station and data corresponding to northern Georgia, and 76 THI with one station and data corresponding to southern Georgia. The rate of decline after the threshold was about .27 kg/ unit THI in all cases. Studies on heat tolerance based on information from only a few weather stations can be done without a significant decrease of accuracy. An additional increase of accuracy can be obtained by accounting for a different onset of heat stress within each station.

Key Words: Heat Tolerance, Dairy cattle, THI

305 Overview of progeny-test programs of artificial-insemination organizations in the United States. H.D. Norman^{*1}, R.L. Powell¹, J.R. Wright¹, and C.G. Sattler², ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD* ²*National Association of Animal Breeders, Columbia, MO.*

Characteristics of progeny-test (PT) programs of US artificial-insemination (AI) organizations were examined for changes since 1959 by breed and sampling year: 1) bull age at semen distribution, daughter birth, and daughter calving; 2) sire, dam, and maternal grandsire age at bull birth; and 3) numbers of PT daughters and herds. State trends were documented for 1) PT participation, 2) percentage of cows that were PT daughters, and 3) percentage of PT daughters that were enrolled in a breed registry herdbook. Mean number of bulls progeny tested by major AI organizations annually from 1996 through 1998 was 10 for Ayrshires, 21 for Brown Swiss, 20 for Guernseys, 1248 for Holsteins, 105 for Jerseys, and 3 for Milking Shorthorns. Mean ages of ancestors at bull birth decreased across time and were 85 mo for sire, 48 mo for dam, and 136 mo for maternal grandsire for Holsteins recently progeny tested; corresponding ancestor ages for Jerseys were 78, 49, and 131 mo. Mean bull age at semen distribution was 16 mo; mean bull ages at daughter birth and calving decreased across time and were 29 and 56 mo (Holsteins) and 32 and 58 mo (Jerseys) for 1992 through 1994, the most recent complete PT years. Mean numbers of PT daughters and herds were 65 and 44 for Holsteins and 48 and 30 for Jerseys. For Holstein bulls that entered AI service in 1994, 22% of PT daughters were in California, 13% in Wisconsin, 12% in New York, and 10% in Pennsylvania and Minnesota. Percentage of first-lactation cows that were PT daughters has increased over time; was 15% overall in 1994; and varied from 4 to 25% for states with >500 cows. Percentage of PT daughters enrolled in breed registry herdbooks was 24% for Holsteins and 78% for Jerseys in 1998. The dairy industry has been able to reduce the PT generation interval by selecting younger parents of PT bulls and by distributing and using semen more quickly.

Key Words: Artificial insemination, Progeny test, Sire sampling

306 Characterization of dairy production systems in Interbull member countries. K.A. Weigel and N.R. Zwald^{*}, *University of Wisconsin, Madison.*

The objective of the study was to examine and describe the characteristics of dairy production systems in countries that participate in international sire evaluations, and to identify the factors that cause lactation performance of a sire's progeny to differ between countries. Test day data from first lactation Holstein cows in Canada, USA, Finland, Israel, Czech, Ireland, Switzerland, Belgium, Austria, and Estonia were used. These data included 95,149 herds, 6,824,413 cows, and 58,862,259 test day records from cows calving between 1/1/90 and 12/31/97. Average herd size ranged from 10 cows in Finland to 203 cows in Israel. Peak yield was highest in Israel at 35.6 kg and lowest in Estonia 16.9 kg. Days to peak yield were 85 days in Israel compared to 10 days in Estonia. Percentage of cows still in milk at 280 days varied from 78 percent in Belgium to 42 percent in Ireland. Median days in milk ranged from 271 days in Ireland to 317 days in Belgium. Persistency was defined as the ratio of average amount of milk at 260 days to average amount of milk at 60 days. It varied from 0.863 in Israel to 0.627 in Ireland. Other factors, such as temperature, humidity, genetic composition of the mates, etc. also differs widely between countries and between herds within a country. Currently, differences in production systems between countries are taken into account in international sire evaluations. However, variation in management or climate within countries is ignored, and future research should focus on identifying and prioritizing the factors that

cause genetic correlations to be less than one between environments. It may then be more reasonable to define traits based on knowledge of the production environment in each herd, as opposed to defining traits based on political boundaries.

Key Words: International evaluation, Interbull, Genotype by Environment interaction

307 A comparison of Holstein Friesian cows from the Northern Hemisphere and New Zealand grazing pasture or fed a total mixed ration. E.S. Kolver^{*1}, A.R. Napper¹, and L.D. Muller², ¹*Dairying Research Corporation Ltd., Hamilton, New Zealand,* ²*Pennsylvania State University, University Park.*

During the last decade the use of Northern Hemisphere (NH) Holstein Friesian (HF) genetics internationally has been high. Countries such as New Zealand (NZ) use a dairy production system which is different from that in which the United States/Netherlands HF genotype was originally selected. This study compared the performance of NH and NZ HF dairy cows on an all-pasture diet in a seasonal calving system. Genotype x diet interactions were investigated during the year-long study by comparing primiparous cows fed either an all-pasture diet (Grass) or a TMR of corn silage, grass silage, and concentrate. The four treatments in this 2 x 2 factorial experiment were NZ Grass (n=14); NH Grass (n=9); NZ TMR (n=15); and NH TMR (n=10). Each treatment represented eight sires and had the same genetic merit. Compared with NZ HF, NH HF had a higher body weight and produced more milk, but milksolids yield (fat + protein), efficiency of milksolids production, and persistency of lactation were not significantly different. Compared with HF fed Grass, HF fed TMR produced more milk and milksolids, were more efficient, had a greater persistency of lactation, and ended lactation with a greater body weight. An important result was the inability of NH Grass to gain body weight, despite a generous pasture allowance. NH Grass ended lactation weighing 77 kg less than at pre-calving, whereas NZ Grass weighed 5 kg less. Compared with the NZ HF genotype, the high genetic merit NH HF produced the same yield of milksolids, but failed to maintain body weight in an all-pasture system.

Genotype (G) Diet (D)	NZ		NH		G	P<	
	Grass	TMR	Grass	TMR		D	G x D
Milk, kg	3317	5036	3597	5898	<0.01	<0.001	ns
Milksolids (MS), kg	281	380	271	401	ns	<0.001	ns
Efficiency, kg MS/kg BW ^{0.75}	3.11	4.0	2.74	3.82	ns	<0.001	ns
Decline in milk, %/ month	10.4	5.9	9.5	4.8	ns	<0.001	ns
Body weight at season end, kg	434	501	464	575	<0.001	<0.001	ns
Body weight change, kg	-5	61	-77	56	<0.01	<0.001	<0.01

Key Words: Holstein, Genotype, Diet

308 Associations between liability to clinical mastitis and culling in Norwegian cattle. B Heringstad^{*1}, R Rekaya², D Gianola², G Klemetsdal¹, and K.A. Weigel², ¹*Department of Animal Science, Agricultural University of Norway, Ås, Norway,* ²*Department of Dairy Science, University of Wisconsin, Madison.*

A Bayesian bivariate threshold model with Gibbs sampling was used to study associations between liability to mastitis and culling in Norwegian Cattle. The two traits were clinical mastitis (CM) and culling (CU), scored as binary, based on whether or not a cow had at least one case of CM during an "opportunity" period (OP), and whether or not the cow was culled before the end of the OP. Two OP were considered: from 30d before calving to either 120d or 300 d postpartum. Data were from 13,070 first-lactation daughters of 250 sires in 1868 herds. The bivariate linear model for liabilities to CM and CU included age x season of calving, herds (random), sires (random, 482 bulls in pedigree) and a residual. The posterior mean (SD) of heritability of CM was 0.08 (0.02) for both OP. Heritability of culling was 0.01 (0.01) for 120 d and 0.02 (0.01) for 300 d. Posterior means (SD) of genetic, herd and residual correlations between CM and CU were: 0.48 (0.24), -0.10 (0.07) and

0.19 (0.02), respectively, for 120d, and 0.53 (0.21), -0.22 (0.07) and 0.10 (0.02) for 300d. Estimates were similar when the correlation between herd effects on CM and CU was 0. Culling before the end of the OP may produce bias in analyses of CM, and a bivariate analysis of CM and CU is one way of taking this into account.

Key Words: Clinical mastitis, Dairy cattle, (Co)variance components

309 Genetic correlation between fertility and body condition score (change), scored during type classification. R. F. Veerkamp^{*1}, E. P. C. Koenen², and G. de Jong², ¹*ID-Lelystad, The Netherlands*, ²*NRS, The Netherlands*.

Twenty type classifiers have visually scored body condition (BCS) of over 150,000 first lactation heifers since Oct. 1998. The objective of this study is to estimate the genetic correlation between (change in) body condition score and fertility. Insemination records were retrieved for all heifers calving between Oct. 1997 and Jan. 1999 for 601 sires that had daughters with BCS in this period (n=70,010). Days till first service (DFS) and inter calving interval (CIV) were derived from calving and insemination dates (n=338,653 and 124,086, respectively). First service conception (FSC) was scored as zero when cows had more than one service, as one when cows had only 1 service and a next calving, and missing for all others (n= 238,825). Genetic correlations of DFS, CIV, and FSC with both level and change of BCS were estimated using a random regression sire model. Fixed effects included were for all traits: breed group, year-month of calving, herd, and a quadratic regression on age at calving; for BCS were added: classifier, and a cubic regression on DIM of scoring; for FSC DIM at first service was added. Heritability of BCS was 0.29. For DFS, CIV and FSC the heritabilities were 0.06, 0.06, and 0.03, and the genetic correlations with level of BCS were -0.49, -0.39 and 0.37, respectively. Correlations with the slope for BCS were 0.11, 0.15 and -0.26 for the fertility traits, respectively. Hence, body condition score is an easy to measure predictor of genetic merit for fertility, as a lower level of body condition score is genetically associated with poorer fertility.

Key Words: Body condition score, Fertility, Heritability

310 Genetic and phenotypic correlations between body condition scores and productive and reproductive performance. C.D. Dechow^{*1}, G.W. Rogers¹, and J.S. Clay², ¹*Pennsylvania State University, University Park*, ²*Dairy Record Management Systems, Raleigh, NC*.

The objectives of this study were to describe the genetic and phenotypic relationships among body condition scores (BCS), production traits and reproductive performance. Producer recorded BCS at calving, postpartum, pregnancy check, and at dry off were provided by Dairy Records Management Systems in Raleigh, NC through the PCDART program. After edits, 27,813 cows had BCS available at one or more periods in first lactation, while 20,952 cows had BCS available in second lactation. Mature equivalent (ME) milk, days to first service (DFS) and services per conception (SPC) were available. Genetic and phenotypic correlations were estimated assuming an animal model using Derivative Free REML. Herd-year-season effects and age at calving were included in all models. The prior calving interval was included in models for second lactation. Analyses that included reproductive traits were conducted with and without ME milk as a covariable. The genetic correlation between BCS at calving and ME milk was 0.02 in first lactation and 0.27 in second lactation. Genetic correlations between ME milk and BCS at periods other than calving ranged from 0.23 to 0.43. Phenotypic correlations between BCS and ME milk were near 0 at calving and were negative at all other periods. After adjustment for ME milk, genetic correlations between BCS and DFS ranged from 0.09 to 0.72. Phenotypic correlations were negative and small in both lactations. Genetic correlations between BCS and SPC at calving were positive. Genetic correlations between BCS at periods other than calving and SPC were near 0 in first lactation, and were negative in second lactation. Most phenotypic correlations were near 0, but were positive between BCS at dry off and SPC. Higher BCS during the lactation were negatively related to production both genetically and phenotypically, but the relationship was moderate. Higher BCS during the lactation were genetically associated with improved reproductive performance.

Key Words: Body Condition Score, Correlations, Reproduction

311 Impact on body weight of divergent selection for body size. B.J. Heins^{*1}, L.B. Hansen¹, A.J. Seykora¹, and G.D. Marx², ¹*University of Minnesota, St. Paul, MN*, ²*University of Minnesota, Crookston, MN*.

Body weights of Holstein cows selected for small and large body size from the Northwest Research and Outreach Center and Pedigree Indexes (three generations of sires) for standardized transmitting abilities (STA) of type traits from Holstein Association USA were compared. Body weights (kg), pre-adjusted for age at calving, were measured for 359 first-lactation cows (1983-1994). Correlations between body weight and a single or composite STA were: stature (.48), strength (.48), body depth (.48), udder depth (.39), stature + strength (.49), stature + body depth (.48), and Minnesota Index ((2*stature + strength + body depth)/4, .48). Body weights were regressed on each individual STA and each combination STA. R-squares were stature (.23), strength (.23), body depth (.23), udder depth (.15), stature + strength (.23), stature + body depth (.23), and Minnesota Index (.23). The regression coefficient for the Minnesota Index was 8.0 kg. Multiple regression coefficients for stature and strength were 2.26 kg (stature) and 5.83 kg (strength) and for stature, strength and body depth were 3.73 kg (stature), 11.09 kg (strength), and -7.20 kg (body depth). Alternative weights on stature and strength were examined: 1:1, 1:2, 1:3, 1:4, 1:5, and 1:2.5. The highest R-square (.236) was for 1(stature):2.5(strength), compared to .233 for the Minnesota Index. An increase of one STA for Pedigree Index for the Minnesota Index resulted in an increase of 8.0 kg of body weight for first-lactation cows immediately postpartum. Body size for lines differed by 52.2 kg immediately postpartum at first calving, 68.0 kg at second calving, and 79.4 kg at third calving. The regression analysis suggests that one STA for the Minnesota Index would equate to 8.0 kg difference for first lactation, 10.3 kg for second lactation, and 12.2 kg for third lactation; therefore, the mean of one STA for the first three lactations was about 11kg. Active AI sires have STA for the size traits that range from roughly -1.5 to +3.5, which is a range of 5 STA, and corresponds to a 55 kg difference in body size. The increase over time of Pedigree Index for size of the large line demonstrates a trend of increased body size of US Holsteins.

Key Words: body size, genetics, STA

312 Smoothing splines estimation of genetic variation in glucocorticoid-induced down-regulation of adhesion molecules in bovine neutrophils. R. J. Tempelman^{*1}, P. M. Saama¹, A. E. Freeman², S. C. Kelm², A. L. Kuck³, M. E. Kehrli, Jr.⁴, and J. L. Burton¹, ¹*Department of Animal Science, Michigan State University, East Lansing* ²*Department of Animal Science, Iowa State University, Ames*, ³*Genex, Inc., Shawano, WI*, ⁴*USDA-ARS, National Animal Disease Center, Ames, IA*.

Neutrophils use a variety of leukocyte and endothelial cell adhesion molecules to contact the vascular endothelium and migrate through it into sites of infection and inflammation. Previous work has shown that neutrophil CD62L and CD18 expression are sensitive to glucocorticoids, stress hormones that impair neutrophil migration and increase disease susceptibility in cattle and other animals. Our current objective was to assess genetic variation for neutrophil sensitivity to glucocorticoids. Smoothing splines mixed effects models were used to estimate genetic and non-genetic sources of variation for neutrophil expression of CD62L and CD18 before, during, and after three consecutive days of dexamethasone administration (0.04 mg/kg/d) to 60 registered Holstein artificial insemination bulls. Dexamethasone generally caused the predicted down-regulation of both adhesion molecules in this study. Heritability estimates (h^2) for CD18 expression were not influenced by dexamethasone administration and were relatively moderate in size (0.12-0.34) across days. Heritability estimates for CD62L expression, however, were influenced by dexamethasone administration, which exposed substantially greater additive genetic variation ($h^2 = 0.20$) in this phenotype compared to pre-treatment responses ($h^2 = 0.02$). When CD62L expression was measured as the percentage of neutrophils with detectable CD62L, heritability estimates were as high as 0.61, but precipitously fell after dexamethasone treatment to a low of 0.03 during recovery from dexamethasone-induced down-regulation. These results imply that genetic selection for neutrophil expression of adhesion molecules and their sensitivity to glucocorticoids may be possible.

Key Words: Health, Heritability, Leukocyte adhesion molecules

313 Relationships among calthood diseases and sire transmitting abilities for measures of immune function. D. L. Nash^{*1}, A. E. Freeman¹, A. L. Kuck², S. A. Schnell², and M. E. Kehrl, Jr.³, ¹*Iowa State University, Ames*, ²*GENEX*, ³*NADC-USDA-ARS, Ames, IA*.

The objectives of this study were to determine the relationships between daughter diseases recorded during calthood and sire transmitting abilities for measures of immune function. Fifty-four post-pubertal Holstein bulls awaiting progeny test were treated with dexamethasone to allow their immune systems to mimic the periparturient immunosuppression experienced by dairy cows. Fifteen *in vitro* tests of immune function were performed on these 54 bulls the week before, during, and after dexamethasone induced immunosuppression. Transmitting abilities were estimated for each test of immune function. Disease incidences and treatment data were recorded from birth through one year of age on 2968 progeny test daughters (in 505 herds in Wisconsin, Minnesota, and Iowa) of these bulls. A total of 73 calves (3%) had scours and 43 calves (1%) had pneumonia. All diseases combined were experienced by 139 calves (5%). Incidence of scours, pneumonia, and all diseases (binary variables) were regressed on herd, season of birth, age (in days) when the disease occurred (measure of time at risk), and sire transmitting abilities for measures of immune function taken one at a time. Logistic regression was used to estimate odds ratios. Daughters of sires that transmit higher antibody dependent neutrophil cytotoxicity had higher incidence of all diseases (odds ratio was 6.3, $P = 0.07$). Other sire transmitting abilities for measures of immune function were not significantly associated with daughter diseases measured during the first year of life. However, disease incidences were low, making it difficult to detect relationships.

Key Words: disease, immune function, sire transmitting abilities

314 Genotype x environment interactions in milk yield and quality in Angus, Brahman, and reciprocal-cross cows on different forage systems. M. A. Brown^{*1}, A. H. Brown, Jr.², W. G. Jackson³, and J. R. Miesner³, ¹*USDA-ARS, El Reno, OK*, ²*University of Arkansas, Fayetteville*, ³*USDA-ARS, Booneville, AR*.

Milk yield and quality were observed on 93 Angus, Brahman, and reciprocal-cross cows over three years to evaluate the interactions of direct and maternal breed effects and heterosis with forage environment. Forage environments were common bermudagrass (BG), endophyte-infected tall fescue (E+), and a rotational system of both forages where each forage (BG or E+) was grazed at appropriate times of the year (ROT). Milk yield (MY) was estimated each of six months (April-September) by method of milking machine and converted to a 24-h basis. Milk fat (MF), milk protein (PRO), and somatic cell count (SCC) were measured by a commercial laboratory. The natural log of SCC was used for analyses. Heterosis for 24-h MY was large and similar among forages, averaging 2.4 kg ($P < .01$). There was little evidence of maternal effects for MY for any forage. Direct effects for MY were similar among forages and averaged 2.2 kg in favor of Brahman ($P < .10$). There was little evidence of heterosis or maternal breed effects for MF. Direct breed effects for MF were similar across forages and averaged .86% in favor of Brahman ($P < .01$). There was little evidence of direct or maternal breed effects for PRO nor was there evidence of forage effects for this trait. Purebred cows exceeded crossbreds in PRO by .13% on ROT ($P < .10$). Crossbred cows had lower SCC than purebreds on E+ ($P < .10$) but heterosis on BG and ROT was not significant. Maternal breed effects for SCC favored the Brahman dam on BG ($P < .05$) but not on E+ or ROT. Direct breed effects for SCC were small and unimportant. These results suggest that direct and maternal breed effects and heterosis for milk yield and quality were relatively stable across the forage systems evaluated.

Key Words: Genotype x Environment, Crossbreeding, Beef Cattle

315 Analyses of cow weight in beef cattle with random regression models. J. Arango^{*1}, L. V. Cundiff², and L. D. Van Vleck³, ¹*University of Nebraska, Lincoln*, ^{2,3}*USDA, ARS, US Meat Animal Research Center*, ²*Clay Center, NE*, ³*Lincoln, NE*.

Data from the first four cycles of the Germplasm Evaluation Program were used to evaluate weights of Angus, Hereford, and F1 cows produced by crosses of 22 sire and two dam (Angus and Hereford) breeds. Four weights per cow-yr were available from two through eight yr of age

(AY) with age coded in months (AM). Weights ($n=61798$) were analyzed with REML fitting a random regression model (RRM), regressing on orthogonal (Legendre) polynomials of AM. The models included fixed regression on AM and effects of cow line, age in years, season of measurement and their interactions, year of birth and pregnancy-lactation codes. The random part of the models fitted RRM coefficients for additive (a) and permanent environmental (c) effects. The resulting covariance functions were used to estimate covariances for all ages in the data. Temporary environmental effects were modeled to account for heterogeneity of variance for the AY. Quadratic fixed regression was sufficient to model population trajectory and was fitted in all analyses. Different sets of models varied the order of fit of a and c coefficients. Models were compared using likelihood ratio tests. The best model included linear and quartic regression coefficients for a and c respectively. Coefficients for c were highly correlated, so estimation with a reduced cubic order did not reduce likelihood significantly. Additive and phenotypic variances increased with cow age, especially for older cows. The surface of the plots of permanent environmental and phenotypic covariances were not smooth. Heritabilities for AM were in the range of .38 (36 mo) to .78 (94 mo) with some fluctuation especially for extreme ages. Genetic correlations were high for most age combinations, with the lowest value (.70) between extreme ages (19, 103 mo). Permanent environmental correlations were more erratic. Results showed that cow weights do not fit a repeatability model with constant variances.

Key Words: Growth, Genetic Parameters, Heritability

316 Parameterization of random regression models for beef cattle data. L. A. Kuehn^{*}, B. L. Golden, and R. M. Bourdon, *Colorado State University, Fort Collins*.

Random regression models have been used to analyze data with multiple records per animal. In most beef cattle data sets, each animal only has one record for the trait of interest. The objective of this study was to determine the number of records per animal required to parameterize a random regression model. We simulated five records for each of 20,000 animals for the following traits: days to slaughter (CONTROL; no random regression), days to reach a specific backfat thickness (BF; days were regressed on backfat depth), and days to reach a specific weight (WT; days were regressed on weight). Phenotypic observations were calculated as the sum of breeding values and environmental effects sampled from multivariate normal distributions. We simulated WT and BF phenotypes using a constant set of backfat or weight observations. Observations from the CONTROL model were simulated to be either 20% or 40% heritable. Records from WT and BF models were simulated at 20% and 40% heritability for each trait (at the highest level of backfat depth or weight), crossclassified with two proportions of additive variance in the intercept term vs. the linear regression term. Data for BF were simulated using a correlation between the intercept and linear coefficients of -.20. The corresponding correlation was zero for WT data. We evaluated parameterization of BF and WT relative to CONTROL by comparing average accuracy of intercept and regression genetic predictions as well as average accuracy of predicted breeding values at final backfat depth or weight endpoint. Breeding values were predicted using the same model used for simulation and incorporating 1, 3, or 5 records per animal. Average accuracy at final backfat depth or weight ranged from .67 to .90, .66 to .88, and .66 to .90 in the CONTROL, BF, and WT models, respectively. Results indicate that one record per animal is sufficient to obtain reliable estimates of breeding values using random regression models that include intercept and linear terms only.

Key Words: Regression, Genetic Models, Simulation

317 Comparison of models for estimation of genetic parameters of mature weight of Hereford cattle. J. M. Rumph^{*1}, R. M. Koch¹, K. E. Gregory², L. V. Cundiff², and L. D. Van Vleck³, ¹*University of Nebraska, Lincoln*, ^{2,3}*USDA, ARS, US Meat Animal Research Center*, ²*Clay Center, NE*, ³*Lincoln, NE*.

Three different models were used to analyze mature weight records from three selection lines, selected on weaning weight, yearling weight, and an index of yearling weight and muscle score, respectively, and one control line of Hereford cattle. Weights were measured a maximum of three times per year; at the time of brand clipping (BC, generally prior to calving), before breeding (BB), and at palpation (PA, as calves were weaned). All models included year x age x line, dam age x line, pregnancy status x line, and birth and method of rearing of calf x line as fixed

effects. Additionally, each model included a covariate for the interval between calving and when the weight was taken and a random permanent environmental effect of the cow. All models were used to analyze each of three weights separately in univariate analyses with REML. The full model also included maternal genetic and permanent environmental effects of the dam. The second model included an overall effect of the dam. The third model did not include any maternal effects. The three models were significantly different based on likelihood ratio tests. The best model was the full model. With the full model, parameter estimates for direct h^2 (SE) were .79 (.09), .74 (.08), and .67 (.08) for BC, BB, and PA weights, respectively. Estimates for maternal h^2 were .07 (.03), .12 (.03), and .11 (.03) and the correlations between direct and maternal genetic effects were -.72 (.12), -.67 (.07), and -.63 (.09). Estimates of fractional variance due to permanent environmental effects of the cow were .00 (.06), .00 (.05), and .00 (.05) and of permanent environmental effects of the dam of the cow were .03 (.02), .05 (.02), and .06 (.02). Fractional estimates of residual variance were .27 (.01), .29 (.01), and .33 (.01). Maternal effects appear to be of some importance for mature weight and therefore should be considered in models for genetic evaluation of mature weight.

Key Words: Heritability, Growth, Beef Cattle

318 Birth and weaning traits of progeny of Hereford, Angus, Norwegian Red-Swedish Red and White, Friesian and Wagyu sires. L.V. Cundiff*¹, ¹USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Data were obtained on 1,384 calves born and 1,285 calves weaned resulting from artificial insemination matings of Hereford (H, 32 sires), Angus (A, 30), Norwegian Red-Swedish Red and White (NS, 14 and 16, respectively, considered same breed because of open herd books), Friesian (F, 24 non-Holstein influenced), and Wagyu (W, 19) sires to Hereford, Angus, and composite MARC III (1/4 each Angus, Hereford, Red Poll, and Pinzgauer) dams. Data on gestation length (GL), unassisted calving percentage (CE), survival to weaning (SW), birth weight (BW) and 200-d weaning weight (WW) were analyzed by least squares procedures using a model that included random effects for sire in sire breed and fixed effects for sire breed, dam breed, sex of calf, age of dam (4,5,...10 yr), birth year (1997 and 1998), sire breed x dam breed and any other two factor interactions that were significant ($P < .05$) for each trait. Effects of sire breed were significant ($P < .05$) for GL, CE, BW, and WW, but not for SW. The means for H, A, NS, F, and W sired progeny were 284.1, 282.3, 282.2, 281.4, and 286.9 d, respectively for GL with a mean least significant difference ($LSD < .05$) of 0.8 d. Corresponding sire breed means were 96.7, 96.8, 99.4, 99.2, and 99.3 % for CE ($LSD < .05 = 2.4\%$); 41.9, 39.1, 38.6, 39.4, and 36.4 kg for BW ($LSD < .05 = 0.8$ kg); and 231.1, 229.1, 225.8, 221.1, and 208.0 kg for WW ($LSD < .05 = 4.4$ kg). In spite of significantly longer gestation length, progeny of W sires had lighter BW and greater CE than progeny of A or H sires. Progeny of W sires did not differ in CE from progeny of NS or F sires. At weaning, progeny of H and A sires were heavier than those of NS sires, which were in turn heavier than those of F sires. Progeny of W sires were significantly lighter than those of all other sire breeds at weaning.

Key Words: Beef Cattle, Breeds, Germplasm

319 Correlation amongst five body linear measurements of Zebu cattle. O.T.F. Abanikanda*¹, A.O. Leigh², O. Olutogun², and O.Y. Apena², ¹Lagos State University, ²University of Ibadan.

Linear measurements of five body dimensions of the Zebu cattle brought for slaughter at the cosmopolitan Abattoir and lairage in Lagos, Nigeria were taken and evaluated. 454 cattle comprising 362 male and 92 female were included in this study. The measurements taken includes Head to shoulder (HDS), Shoulder to drop (STD), Height at withers (HTW), Heart girth (HTG) and Body length (BLT). The mean values \pm Standard error (cm) for the five measurements are 67.95 ± 0.52 , 126.47 ± 0.80 , 135.52 ± 0.68 , 186 ± 1.67 and 197 ± 1.21 respectively. In this study, HDS ranges from 33 - 92cm; STD, 49 - 168cm; HTW, 92 - 182cm; HTG 104 - 262cm and BLT, 102 - 255cm. With the exception of the correlation between HTG and HTW which was not significant ($P > 0.05$) all other parameters studied were highly significant ($P < 0.001$). In the analysis of variance, using BLT as the dependent variable and sex as a fixed factor, while the other four body dimensions are used as covariates, all factors

studied except sex were highly significant ($P < 0.05$) on BLT. The coefficient of variation (CV) and coefficient of determination (R-squared) for this analysis was 5.72 and 0.81 respectively. The result of this study reveals that there are inter-relationships amongst the five body linear measurements of Zebu cattle

Key Words: cattle, linear measurement

320 Effects of the calpastatin system on growth of Angus bulls. M. E. Davis*¹, H. Y. Chung¹, H. C. Hines¹, and D. M. Wulf², ¹The Ohio State University, Columbus, ²South Dakota State University, Brookings.

Effects of the calpastatin system on growth and blood serum insulin-like growth factor I (IGF-I) concentration were examined in 47 purebred Angus bulls divergently selected for IGF-I at the Eastern Ohio Resource Development Center (EORDC). PCR-SSCP (single strand conformation polymorphism) analysis was conducted to search for genetic polymorphisms. The PCR primer selection was based on bovine calpastatin cDNA from domains L (CAST1) and IV (CAST28). The IGF-I concentration on d 28 (IGF28), 42 (IGF42), and 56 (IGF56) of the 140-d post-weaning test was measured. Birth weight (BW), weaning weight (WW), on-test weight (ONW), weight on d 28 (W28), 42 (W42), and 56 (W56) of the postweaning test, and off-test weight (OFW) also were recorded. The statistical model included fixed effects of calpastatin genotypes, IGF-I selection line (high vs. low), age of dam, and age of bull as a covariate. Three genotypes (AA, AB, and BB) were detected for both loci. Significant influences of CAST1 genotypes on ONW, W28, W42, W56, and W140, and of CAST28 genotypes on W28 and W42 were observed. CAST1 and CAST28 genotypes did not explain significant variation in IGF28, IGF42, and IGF56, but CAST28 genotypes tended to influence mean IGF-I concentration ($P = .06$). The calpastatin polymorphisms reported here may provide useful information for marker assisted selection for weight traits in beef cattle.

Key Words: Calpastatin, IGF-I, PCR-SSCP

321 Effects of calpain and calpastatin genotypes on calpastatin activity and meat tenderness in Angus bulls. H. Y. Chung*¹, M. E. Davis¹, H. C. Hines¹, and D. M. Wulf², ¹The Ohio State University, Columbus, ²South Dakota State University, Brookings.

Effects of the calpain and calpastatin system on calpastatin activity, myofibril fragmentation index, pH, and meat tenderness were examined in 47 purebred Angus bulls reared at the Eastern Ohio Resource Development Center (EORDC). The bulls were divergently selected for blood serum insulin-like growth factor I (IGF-I) concentration. Genetic variants were found using PCR-RFLP and SSCP analysis of the u-calpain and calpastatin loci. PCR primers were selected based on the bovine cDNA sequence for calpastatin domain I, and the rat cDNA sequence for u-calpain domain II. Bulls were slaughtered at approximately 13 to 15 mo of age, and longissimus muscle samples were prepared for determination of calpastatin activity (CAC), Warner-Bratzler Shear Force (WBS), pH, and myofibril fragmentation index (MFI). The statistical model included calpastatin genotypes, calpain genotypes, age of dam, and IGF-I selection line as fixed effects, as well as age of bull as a covariate. Genetic polymorphisms were detected for calpastatin (AA, AB, AC, BB, BC and CC) and u-calpain (AA, AB, and BB). Calpastatin and u-calpain genotypes explained significant variation in calpastatin activity, but not in WBS. Least significant differences for CAC among calpastatin (AA > AB > BC > AC > CC > BB) and u-calpain genotypes (BB > AA > AB) were found. A strong positive residual correlation was detected between calpastatin activity and WBS ($r = .41$; $P < .05$), and a weak negative relationship was detected between CAC and MFI ($r = -.27$; $P = .12$). It may be possible to use calpastatin and u-calpain genotypes classified by PCR-RFLP and SSCP in marker assisted selection programs to decrease calpastatin activity.

Key Words: Calpastatin, Meat Tenderness, PCR-RFLP

322 Association of two Pit-1 gene polymorphisms with growth rate in beef cattle. Qun Zhao*, M.E. Davis, and H.C. Hines, *The Ohio State University, Columbus.*

Growth rate, which is under the control of multiple genes, is an economically important trait in livestock. Pit-1 is a pituitary specific transcription factor that helps regulate the expression of growth hormone (GH). Therefore, the Pit-1 gene may be a good candidate gene for growth rate. Detecting genetic variations in the Pit-1 gene and relating them to growth rate could be helpful in development of marker-assisted selection (MAS) programs in animal breeding. A new SSCP polymorphism detected in intron 5 and a PCR-RFLP *Hinf*I polymorphism in exon 6 were studied in Angus beef cattle, which were divergently selected for high or low blood serum IGF-I concentration. The intron 5 polymorphism was examined in 185 cattle and the exon 6 polymorphism in 416 cattle. For the intron 5 polymorphism we found genotypes AB and BB with frequencies of .09 and .91 respectively. No AA individual was found in this sample. For the exon 6 polymorphism, genotypic frequencies of .11, .45 and .44 were observed for AA, AB, and BB, respectively. The associations of the polymorphisms with growth rate were also analyzed using the GLM procedure in SAS. For the intron 5 polymorphism a linear model was fitted for birth weight, preweaning gain, weaning weight, on-test weight, off-test weight, and weight at d 56 of the 140-d postweaning test. No significant associations between the genotypes and these growth traits were found. A moderate association of genotypes with weight at d 56 was found ($P=0.08$), and genotype AB had a higher d 56 weight. Allele A could be associated with superior d 56 weight. For the exon 6 polymorphism a linear model was fitted for birth weight, pre-weaning gain, weaning weight, and off-test weight. Significant associations were found between exon 6 genotypes and birth weight ($P=0.03$) and preweaning gain ($P=0.01$). Therefore, this Pit-1 polymorphism appears to affect growth traits in Angus beef cattle and may be a candidate for use in MAS. Further study of these polymorphisms in a larger sample is warranted.

Key Words: Pit-1, Polymorphism, cattle

323 Identification of quantitative trait loci affecting meat quality in a Berkshire by Yorkshire 3 generation family. M. Malek¹, J.C.M. Dekkers*¹, H.K. Lee¹, T.J. Baas¹, K.P. Prusa¹, E. Huff-Lonergan¹, and M.F. Rothschild¹, ¹*Departments of Animal Science, Food Science and Human Nutrition, Iowa State University, Ames.*

The techniques of molecular genetics and gene mapping have rapidly progressed. These methods, coupled with advances in human genetics, have opened new vistas for investigators wishing to identify genes that control quantitative traits (quantitative trait loci or QTL). A three-generation resource family was developed at Iowa State University to study individual effects of genes on meat quality traits in pigs. This family was developed using two Berkshire grand sires and ten Yorkshire grand dams. These F0 animals were mated to produce ten F1 litters. From the F1 litters a total of 65 matings were made in four seasons to produce a total of 525 F2 animals. All F2 animals were phenotyped for birth weight, 16 day weight, growth rate, backfat, loin eye area, drip loss, water holding capacity, firmness, color, marbling, percent cholesterol, ultimate pH, fiber type and several sensory panel and cooking traits. All animals were genotyped for nearly 120 microsatellite markers covering the entire porcine genome. Linkage analysis was performed using CRIMAP version 2.4 software (Green et al. 1990). The regression interval mapping method (Haley et al. 1994) was used to analyze the data. Permutation tests were performed to determine chromosome and experiment-wise significance levels for hypothesis testing. Significant QTL at the chromosome wide 5% level were detected for growth (chromosomes 1, 4, 7, 15), backfat (chromosomes 1, 5, 6, 7, 13, 14) and meat quality traits (chromosomes 1, 2, 4, 5, 8, 10, 11, 13, 14, 15, 17, 18). Additional marker analysis and examination for positional candidate genes is underway. This work was supported by an industry consortium consisting of National Pork Producers Council, Iowa Pork Producers Association, Iowa Purebred Swine Council, Babcock Swine, Danbred USA, DEKALB Swine Breeders, PIC, Seghersgenetics USA, and Shamrock Breeders.

324 Accuracy of DNA pooling to estimate microsatellite allele frequency. J. P. McElroy*¹, H. Zhou¹, J. C. M. Dekkers¹, and S. J. Lamont¹, ¹*Iowa State University, Ames.*

The use of pooled DNA to estimate allele frequencies in groups of individuals is commonly employed to detect Quantitative Trait Loci (QTL) in large populations to reduce the number of genotypings required. The objective here was to examine factors that might affect the accuracy of DNA pooling to estimate the frequency of microsatellite marker ADL0268 in chickens. Two genetically distant, highly inbred (>99%) lines (Leghorn and Fayoumi) were used to generate an F2 population of 159 females, approximating a large full-sibship. The F2 birds were evaluated for six antibody response traits. Equal amounts of DNA from the phenotypic extremes (15% per pool) of each trait were used to create DNA pools. Each pool was independently replicated, resulting in 24 pools. All pools were amplified in two replicates of the polymerase chain reaction (PCR), yielding 48 PCR products. Only the two parental alleles were detected. Allelic frequencies in a pool were estimated by dividing the Genescan peak height of each allele by the sum of the two peak heights. Correlations of frequency estimates between replicates were >0.9 for DNA pools and PCRs, indicating that little variation was due to the pooling or the PCR procedure. Actual allele frequencies in the pools, determined by individual genotyping, ranged from 0.35 to 0.57, but did not differ significantly ($P>0.05$) between the high and low groups for any trait. The intercept and slope of the linear regression of pool on actual frequencies were 0.18 and 0.75. Correlations of actual with estimated frequencies based on individual replicated PCRs per replicate pool ($n=48$), the average of 2 replicated PCRs per replicate pool ($n=24$), and the average of 2 pool replicates per phenotypic group ($n=12$) were 0.551, 0.560, and 0.577, indicating little improvement in allele frequency estimates from pool or PCR replication. Although this experiment only examined one microsatellite marker, the results show that large discrepancies may exist between actual and estimated frequencies, thereby decreasing the efficacy of the DNA pooling technique to detect QTL.

Key Words: QTL, Microsatellite, DNA Pooling

325 Maximizing cumulative discounted response with selection on an identified QTL. R. Chakraborty*¹ and J. C. M. Dekkers¹, ¹*Iowa State University, Ames.*

The standard approach to marker-assisted selection is to select on the sum of the EBV for the quantitative trait locus (QTL) and an EBV for polygenes. Standard QTL selection has been shown to result in less than maximum response. Dekkers and Van Arendonk (1998, Genet. Res. 71:257) developed methods to optimize QTL selection by optimizing weights in an index of the QTL and polygenic EBV. Equal selection in males and females, an additive QTL, and maximization of response at the end of a planning horizon were assumed. The objectives here were to relax these assumptions and to compare multi-generation optimal and stepwise optimal QTL selection to standard QTL selection for maximizing cumulative discounted response. Stepwise optimal selection maximized single generation response each generation and is equivalent to standard QTL selection for additive QTL. Percent selected was 10 and 25% in males and females. Effects of the QTL were known, with the additive effect (a) ranging from 1 to 4 in standard deviations of polygenic EBV, which is equal to accuracy times the genetic standard deviation, and the dominance effect (d) ranging from 0 to 1.5a. QTL frequency was 10, 25 or 50%. Selection was for 10 generations and discount rate was 5 or 10%. For an additive QTL, benefits from multi-generation optimal over standard QTL selection were small; less than 2% greater response when $a=1$ and less than 4% when $a\geq 2$. Dominance increased the benefit of optimal selection; extra responses were up 3 and 6% greater for $a=1$ and $a\geq 2$ when $d=.5a$, up to 4 and 8% greater for $a=1$ and $a\geq 2$ when $d=a$, and up to 6 and 12% greater for $a=1$ and $a\geq 2$ when $d=1.5a$. Extra responses were similar for $a=2, 3, \text{ or } 4$ and tended to decrease with increasing frequency and interest rate. For non-additive QTL, extra responses from stepwise optimal over standard QTL selection were about half as large as those from multi-generation optimal selection. Results show that optimization of QTL selection can result in greater responses, although benefits are small unless the QTL shows dominance. This research was funded by USDA-NRI and PIC.

Key Words: Marker Assisted Selection, Discounting

326 Genome scan for quantitative trait loci for growth and reproductive traits in female mice. F. Siewerdt^{1,2}, E. J. Eisen¹, and D. Pomp³, ¹North Carolina State University, Raleigh, ²Universidade Federal de Pelotas, ³University of Nebraska, Lincoln.

The objective of this research was to identify QTL for growth and reproduction in female mice. Genotypic and phenotypic data were collected on 442 female progeny of *inter se* matings from an F₁ cross between line L6 (small BW) and line M16i (large BW), from two replications. Females were exposed to unrelated F₁ males B6C3F1/J until a copulatory plug was detected. BW were taken at 3, 6, 10 wk and at detection of the copulatory plug (PW); tail length was measured at 10 wk. Females were killed at d 16 of pregnancy to obtain counts on number of corpora lutea (TCL) and number of live (TF) and dead (TD) fetuses; embryo survival rates (ES) were calculated. Genotyping was done at 72 microsatellites in all F₂ females bearing a litter. Each of the 19 autosomes had at least three markers. A model with the effects of replication and litter within replication was fitted to the data. Residuals from this model were used in conjunction with a linkage map for the molecular markers in a composite interval mapping analysis. The putative QTL with largest additive effects ($P < .05$) on BW and tail length were found to be linked with markers in chromosomes (chr) 6, 8, 11, 12, 14, and 19. The major QTL for PW were found in chr 4, 5, 7, 11, 12, 14, and 18. QTL with additive effect on TCL were in chr 4, 11, and 14; significant associations between markers and putative QTL with additive effects were found in chr 9, 13, 14, 17, and 19 for TF and in chr 2, 4, 5, 6, 9, and 17 for TD. ES were affected mainly by QTL with additive effects linked to markers in chr 2, 9, 14, and 17. Putative QTL with the largest dominance effects ($P < .05$) were found for PW in chr 2 and 17, for BW in chr 10, 11, 12, and 17, for tail length in chr 6, 9, and 13, for TCL in chr 11, 17, and 18, for TF in chr 2 and 11, for TD in chr 9, and for ES in chr 2 and 11. There is definite indication of QTL for growth and reproduction. Some QTL may be pleiotropic due to detectable effects on several traits associated with the same markers.

Key Words: Mice, Quantitative Trait Loci, Growth, Reproduction

327 Comparison of approaches for determining significance threshold values for QTL detection. H. K. Lee^{*1}, J. C. M. Dekkers², M. Malek², M. Soller³, R. L. Fernando², and M. F. Rothschild², ¹National Livestock Research Institute, Korea, ²Iowa State University, Ames, ³Hebrew University of Jerusalem.

Setting critical values (CV) for significance tests for detecting quantitative trait loci (QTL) with interval mapping is much debated. Several methods have been proposed to derive CV to control Type I error at the chromosome, experiment, or genome level, accounting for the number and dependence of tests, including the analytical method of Lander and Kruglyak (1995) (LK) and the permutation test (PT) of Churchill and Doerge (1994). Weller et al. (1998) proposed controlling false discovery rate (FDR) as basis for an alternative CV. The goal here was to compare 5% CV based on these 3 methods, recognizing that Type I error rate and FDR have different interpretations and relevance. Phenotypes of 5 meat quality traits and genotypes of 41 markers on 8 chromosomes covering 9.1 M (0.75 to 1.3 M per chromosome) from 525 F₂'s from a swine breed cross were used. Data were analyzed by least squares regression interval mapping with a test every cM. The PT CV were based on 10,000 replicates and FDR CV on tests at every cM. The 5% CV for a single test was 3.1. Experimentwise CV were 9.4 for LK and ranged from 7.1 to 7.4 for PT and from 4.4 to 6.7 for FDR, depending on the trait. Chromosomewise CV ranged from 6.5 to 7.2 for LK, from 4.6 to 5.2 for PT, and from 3.2 to 4.3 for FDR. Chromosomewise FDR behaved erratic due to dependence among tests and could not be obtained for several chromosome-trait combinations, for which FDR was above 5% for all tests, indicating no trait QTL on that chromosome. In conclusion, CV differed substantially between methods, leading to different numbers of QTL detected. FDR resulted in the least stringent CV. This while an FDR of 5% will be conservative for most purposes. This work was supported by an industry consortium of the National Pork Producers Council, Iowa Pork Producers Association, Iowa Purebred Swine Council, Babcock Swine, Danbred USA, DEKALB Swine Breeders, PIC, Seghersgenetics USA, and Shamrock Breeders.

Key Words: QTL Mapping, Significance Test, Breed Cross

328 Fitness of sheep metallothionein 1-a sheep growth hormone (oMt1a-oGH) transgenic mice. E. J. Eisen^{*1} and J. D. Murray², ¹North Carolina State University, Raleigh, ²University of California, Davis.

Objectives were to determine if the oMt1a-oGH transgene shows normal mendelian segregation and if oMt1a-oGH mice exhibit normal growth without the zinc supplementation required to increase plasma oGH levels and stimulate growth. Transgenic mice were reciprocally backcrossed for four generations to high growth and control lines to form lines GM and GR. In the fifth generation, hemizygous transgenic mice (T/-) were crossed within each line. Pooled across backcross generations, there was a deficit ($P < .001$) of T/- progeny in GM (31.6%) and GR (22.2%) compared to expected (50%). In the T/- x T/- cross the combined percentage of homozygous (T/T) and hemizygous transgenic mice was less ($P < .001$) than expected (75%) in both GM (44.2%) and GR (38.5%). Backcross T/- mice had lower ($P < .05$) 3-wk body weights and lower ($P < .001$) 6-wk body weights and 3-6 wk postweaning gains than non-transgenic mice. Similar genotypic differences were found in the T/- x T/- cross. No significant growth differences were found between T/T and T/- progeny. Using segregation ratios from the T/- x T/- mating, the relative fitness estimate of T/T, T/- and -/- (nontransgenic) mice were .345, .223 and 1.0, respectively, in line GM and .218, .205 and 1.0 in line GR. Fitness estimates in the backcross for T/- and -/- were .463 and 1.0 in line GM and .285 and 1.0 in line GR. Abnormal segregation ratios may be due to germline mosaicism or reduced fitness due to differential embryo survival. Reduced growth of oMt1a-oGH transgenic mice when the transgene is switched off suggests a subtle developmental abnormality, which may contribute to a reduction in fitness.

Key Words: Transgene, Growth Hormone, Mice

329 Mutation in exon 5 of bovine prolactin gene is not associated with milk traits in Holstein bulls. I. Parmentier¹, N. Gengler¹, P. Laliberte², W. Holtmann², C. Bertozzi¹, V. Haezebroeck¹, D. Portetelle¹, and R. Renaville^{*1}, ¹Gembloux Agricultural University, Gembloux, Canada, ²Semex Alliance, Guelph, Canada.

The prolactin hormone, PRL, plays a critical role in lactation. This hormone is, primarily responsible for the synthesis of milk proteins, lactose, and lipids, all major components of milk. In addition, PRL has been shown to directly stimulate insulin-like growth factor-I binding proteins, epidermal growth factor, a glycolysated mucin, parathyroid-like peptide, and PRL-inducible proteins in normal and neoplastic tissue. The objectives of this research were to identify mutation in exon 5 of bovine PRL gene and to establish association between observed mutation and milk traits in Holstein bulls DNA was extracted from semen of 1100 Holtsein bulls provided by Semex-Alliance (Guelph, Canada). A mixed model was used to study association between alleles and milk, protein and fat yields. In this model, herd, year, season, parity, lactation, age classes, month of lactation were fixed effects and permanent environment, animal and residual effects were considered as random effects. Using BESS-Scan Mutation Detection and Localization Kit (Epicentre Technologies), a mutation was found in the fifth exon of the PRL gene. By DNA sequencing, a A to G transition was identified at the 718 amino acid of the protein. In our population, allelic frequencies of the A and G alleles were 0.34 and 0.66, respectively. Statistical analysis showed no significant effect of PRL polymorphism at the exon 5 on lactation traits. In conclusion, the PRL polymorphism found in the fifth exon was not associated with lactation traits of Holstein bulls. This polymorphism is, thus, not a tool of choice for using in breeding programs. This research was supported by Belgian Ministry of Agriculture grant 5859 and Semex Alliance, Guelph, Canada.

Key Words: Prolactin, Mutation, Lactation

330 Genetic analysis of candidate gene (RELN) for Weaver Syndrome in Brown Swiss Cattle. S. E. Speidel^{*1}, E. Oberg¹, M. B. Abdallah¹, and S. K. DeNise¹, ¹University of Arizona, Tucson.

Weaver Syndrome or Bovine Progressive Degenerative Myeloencephalopathy (PDME) is a recessively inherited neurological disease described in Brown Swiss Cattle that has been mapped to bovine chromosome 4 (BTA4). To locate the PDME causative gene, human and murine candidate loci have been identified that map to homologous regions on

BTA4. The reelin gene (RELN) has been shown to control neuronal migration in the developing brain in mice; and mutations in the gene have shown similar symptoms to PDME. It maps to the long arm of human chromosome 7, which is homologous to BTA4. Primers developed from human studies were used to amplify a 159-bp fragment, which encompasses positions 1136-1295 of the human RELN sequence. After initial sequencing of direct PCR product, the fragment had a 90.06% homology score with human RELN. Sixteen animals representing nine breeds: Guernsey, Angus, Holstein, Jersey, Brown Swiss, Hereford, Gelbvieh, Limousin and Simmental, were PCR amplified and direct sequenced. Single nucleotide polymorphisms (SNP's) at positions 54 and 69 were identified. Using this information, we will develop either PCR restriction fragment polymorphisms (PCR-RFLP) or single strand conformational polymorphisms (SSCP) to map the gene by linkage analysis in the ARS Cattle Genome Mapping Project.

Key Words: Gene mapping, Dairy cattle, Genetic diseases

331 Genetic analysis of Bovine Progressive Degenerative Myeloencephalopathy (PDME) or Weaver Syndrome in Brown Swiss Cattle. S.K. DeNise*¹ and E. Oberg¹, University of Arizona, Tucson AZ USA.

Eight bovine microsatellite markers have been used to develop haplotypes for carriers of PDME within the Brown Swiss Breed. These markers include TGLA116 (the original marker for PDME), BMS2172, BMS885, DIK8, BM1224, BM6437, BMS495 and INRA072, that encompass a 12.7 cM region of bovine chromosome 4. Haplotypes have been developed for all progeny-tested carrier sires, resulting in a high probability of determining carrier status of progeny from these sires. Using the haplotype test, we have identified a recombinant bull that is a known PDME heterozygote. This bull places the PDME locus telomeric of BM1224. Physical mapping of the region using bacterial artificial chromosome clones (BAC) has identified two human expressed sequence tags (ESTs) near BMS495. These sequences map to human chromosome 7 (Gene Map 98 (NCBI): D7S484-528, 55.6-58.9) and place these ESTs between GHRHR (7p14; 40.1-55.6) and IGFBP3 (7p13-12; 69.4-74.3). If the BAC clone is not chimeric, then these ESTs map centromeric to GHRHR in cattle with the linkage order as BMS495: 69.6; GHRHR: 74.8 and IGFBP3: 82.2 (ARS Cattle Genome Mapping Project). Thus,

there may have been rearrangements between the bovine and human genomes in this region.

Key Words: Gene mapping, Dairy cattle

332 The effects of storage and preservative on genomic DNA extraction from bovine milk somatic cells. G. Robitaille*¹, M. Britten², and D. Petitclerc¹, ¹Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada, ²Food Research and Development Centre, Agriculture and Agri-Food Canada.

Molecular approach of genotyping a huge amount of cow is complicated by the need of cells for genomic DNA extraction. An alternative approach to blood sampling is the use of milk somatic cells. The objective of the study was to define milk storage conditions for an efficient DNA isolation. Individual milk from 3 cows, having different somatic cell count, were processed immediately for DNA isolation or stored at -20, 4, 20, and 37°C for up to 15 days, with or without bronopol or potassium dichromate as preservatives. DNA was extracted using InstaGene Matrix (BIORAD). Briefly, milk was diluted in a phosphate buffered saline and spun. Supernatant and excess of fat were removed, cells were resuspended in 20 µl of water and mixed to 200 µl of InstaGene Matrix (BIORAD). The suspension was incubated for 30 min at 56°C and 100°C for 8 min and kept frozen. PCR amplification (40 cycles : 94 °C - 30 sec, 55°C - 30 sec, and 72°C - 30 sec using Taq polymerase) was carried out on 10 µl of the supernatant in a reaction volume of 25 µl. Two sets of primers were tested on each sample, one that amplifies the bovine kappa-casein gene exon IV to discriminate genetic variants A and B (453 bp), and the other that amplifies the microsatellite region within intro III (246 bp). Results clearly demonstrated that, although fresh sample were more efficient as starting material, it is possible to isolate PCR-grade genomic DNA from milk that were stored up to 15 days at temperatures as high as 37°C. This is particularly true when bronopol was added to milk. SSCP and RFLP of PCR fragments to genotype cows were carried out without problems. In conclusion, isolation of genomic DNA using InstaGene Matrix has proven to be effective with milk stored at various temperatures for up to 15 days. This means that individual milk samples, collected and forwarded to central testing laboratories within 15 days for milk composition analysis, can also be tested for gene polymorphism.

Key Words: Genotyping, DNA extraction, Somatic cells

CONTEMPORARY AND EMERGING ISSUES

333 Proposed new regional project on animal ethics. S. L. Davis*¹, J. R. Males¹, J. C. Swanson², and K. K. Schillo³, ¹Oregon State University, Corvallis, ²Kansas State University, Manhattan, ³University of Kentucky, Lexington.

Writing about Science, Lubchenco (1998. Science 279:491-497) wrote "Part of our collective responsibility to society must include a scientific community-wide re-examination of our goals and alteration of our course, if appropriate." The same is true for animal sciences of course, and with the increasing number of contentious social issues related to animal sciences it is becoming even more important that we conduct such a re-examination. This is basically what Thompson (1998. J. Animal Sci. 77:372-377) suggested in his presentation to ASAS at their 1997 meeting. Thompson (1998) also suggested that one approach to accomplish that re-examination would be to develop a new professional ethic, and one way to accomplish that would be the formation of a new Hatch regional project on Animal Bioethics. As a result, a group of 26 scientists have prepared a proposal to establish such a regional Hatch project titled Animal Bioethics. The objectives of this proposal are:

1. Create a forum in which animal scientists and non-animal scientists (philosophers, social scientists, etc.) may work together to examine and discuss contentious social issues.
2. Provide a means of encouraging the development and coordinating the activities of research projects dealing with bioethics of the animal sciences.
3. Develop mechanisms of outreach that would allow animal scientists to respond directly to consumers and our critics who may question our science and/or production methods.

4. Provide the means for ongoing critical analysis of the animal science professions in the context of their ability to address moral and socio-political issues.

Accomplishment of these objectives will require the participation and collaboration of animal scientists as well as philosophers and social scientists.

Key Words: Regional project, Animal ethics

334 The development and evaluation of Pennsylvania's Humane Society Police Officer Training Course: Animal Husbandry. B.L. Coe*, E.P. Yoder, and D.E. Evans, Pennsylvania State University, University Park.

Recent Pennsylvania legislation (Act 1994-135) requires Humane Society Police Officers investigating animal abuse cases to receive training from a land-grant university regarding animal agriculture. A committee of Penn State specialists, humane society reps, farm organization reps, and PA Dept. of Ag. officials developed a relevant educational program. The program provides instruction in animal husbandry practices, animal behavior, handling, transportation, production systems, and investigation/evaluation of animal cruelty complaints. This project used an Instructional Systems Design framework for development and evaluation of the PA Humane Society Police Officer Training Program: Animal Husbandry. Data were collected from program participants, stakeholders, and a comparison group via detailed surveys. The program was conducted in PA from 1996-99 and 147 people completed the program. This study examined whether the new curriculum to train humane officers prepared them to adequately and reasonably enforce the

Anti-Cruelty Law in PA with relation to agricultural animals. Evaluation results indicate the educational program provided officers a good base of information and experience, along with excellent written and personal contact resources. Participants were also more prepared to visit sites in response to reports of farm animal abuse. Participant attitudes towards animal agriculture did not change substantially, however, officer on-the-job knowledge and confidence did increase considerably. Networking among stakeholders did not increase significantly. Due to the relatively low number of livestock investigations, it was difficult to determine if there was a change in their success subsequent to training. Course materials were determined to be appropriate and participant feedback provided valuable suggestions for future continuing education. Response to the program was positive and even participants who did not typically deal with agricultural animals felt it was educational and worthwhile.

Key Words: Animal husbandry, Teaching, Animal abuse investigation

335 ADDS, a modern program for delivery of knowledge to agriculture. J.M. Mattison*¹, R.M Kattnig², B.R. Eastwood³, M.J. Joyce⁴, and M.B. Oppermant¹, ¹ADDS Center, ²University of Arizona, ³USDA-CSREES, ⁴Wisconsin Milk Marketing Board.

ADDS (Agricultural Databases for Decision Support) is a program that takes a fresh and original approach to addressing the needs of modern agriculture for dependable, research-based information, educational programming and decision support tools. The program consists of a growing number of national perpetual projects oriented toward a commodity (or species), major issue, discipline, or clientele. Projects are comprehensive in scope and bring many of the users needs into one accessible resource. The major concept woven into the fabric of ADDS is open and inclusive national cooperation. This embraces cooperation between the public and private sectors, across states, institutions, departments, disciplines, functions, organizations and groups. Other important concepts of the program include user oversight; peer review and expert selection of materials; and sharing of information resources among projects. ADDS is product oriented, with each component under the leadership, control and ownership of the initiating database group.

Policy for ADDS is set by the public and private sector members of the board of directors of ADDS, Inc., a non-profit educational corporation. This board is composed of up to three directors from each of the database groups. Infrastructure, management and technical support for these projects are provided by the ADDS Center located in Verona, Wisconsin. The center operates under the authority of the ADDS, Inc. board.

ADDS products are electronically published on CD and the web. Participation in the projects is open to all having an interest and expertise to share. New projects are encouraged as a critical mass of individuals to carry out the development is identified. Funding support is sought as a project moves forward. The iterative process of development, distribution to users, user feedback, and further development is expected to keep these products on the leading edge of useful technologies and management systems for agriculture.

Key Words: InfoBases, Decision Support, Extension

336 Behavior of the Holstein dairy farming system in Brazil between 1980 and 1992. B. A. Waltrick*¹, C. N. Costa², and W. J. Koops*¹, ¹Wageningen University Research Center, The Netherlands and ²EMBRAPA Dairy Cattle, Juiz de Fora-MG, Brazil.

The Holstein breed has been successfully used for milk production in many countries, because of its genetic potential for milk production. In Brazil, the Holstein breed performs well under good management practices. This study aimed at giving an overview of the development of the Holstein dairy system in Brazil by evaluating its structure and properties in terms of trends in milk yield from 1980 and 1992. This evaluation shows the persistence of the system in maintaining production over the long term, concerning routine fluctuations in response to disturbances. This research is a partial study on the sustainability of the Holstein dairy system in Brazil.

Data provided by the National Dairy Database consist of lactation records from Holstein cows registered by milk recording services of the Brazilian Holstein Breeders Association from 1980 to 1992. There were 154,053 lactation records available. The most representative system was

selected: cows milked twice a day, from the South and Southeast regions which included 118,802 records from the states of Minas Gerais, Sao Paulo, Parana, Santa Catarina and Rio Grande do Sul. The analyses included the distribution of number of records, level and range of production. Milk yields were adjusted to 305 days.

The development of the milk recording system is reflected by the increasing number of lactation records in the course of the period, independent of lactation number. However, in 1990 the system was evidently disturbed. Its resilience was shown by the capacity to recover in number of records as well as in production level, thus maintaining system stability. The results of the distribution analysis showed an increasing variation in the range of production values. The median showed little variation across years.

Key Words: Holstein cattle, dairy system, milk production

337 Dairy farm modernization in Wisconsin. J. Bewley*, R.W. Palmer, D.B. Jackson-Smith, and D.E. Hemken, *University of Wisconsin, Madison.*

A survey was sent to 694 Wisconsin dairy farms that had increased herd size by at least 40% between 1994 and 1998. Responses from 302 farms were used to (1) determine specific modernization strategies employed, (2) examine impacts of these strategies on herd performance, (3) assess levels of satisfaction with recent changes, and (4) provide information for producers considering future expansion. Herds were categorized for analysis by herd size and type of expansion. DHI information was used to evaluate milk production, days open, and linear somatic cell scores. Mean herd size for surveyed herds was 102 cows in 1994 and 252 cows in 1998 with a long-term goal of 453 cows. Modernization issues examined in this study include strategies for changing milking systems, changing housing, handling animals, handling manure, managing employees, sourcing of animals, and obtaining additional feed. Farms that had built all new facilities had higher milk production, greater labor efficiency, and higher satisfaction with economic performance than those who modified existing facilities or combined older with new buildings. Increased herd size was generally associated with higher milk production, increased labor efficiency, and greater satisfaction with quality of life satisfaction measures. Sixty percent of respondents were using a pit parlor in 1998. These herds had higher production, lower somatic cell scores, greater labor efficiency, and higher satisfaction with their milking systems when compared to those using flat parlors or stall barns with pipelines. Reasons for modernization included: to increase profitability (89%), to improve labor efficiency (73%), to improve working conditions (69%), to get time away from the farm (61%), and to allow a family member to join the operation (34%). All but 6% of the producers responded positively to the question Knowing what you know now, would you do it again? Nearly one-third (29%) of respondents indicated they would expand at a faster rate, and 23% indicated they would expand to a larger size.

Key Words: survey, expansion, user satisfaction

338 Hydrogen Sulfide concentrations downwind from agitated swine manure pits. C. L. Tengman* and R. N. Goodwin, *National Pork Producers Council, Ames, IA.*

Six swine farms of varying size in IA, IL, and MN were selected for the monitoring of ambient air hydrogen sulfide (H₂S) concentrations during the deep pit manure storage agitation and removal activity. Specialized monitoring equipment was used called the MDA Scientific Chemcassette[®] Single Point Monitor (SPM). The SPM's were located at 15.2m and 30.4m intervals downwind from the farm. The primary objective was to gain information on the increase and decrease of hydrogen sulfide levels before, during and after agitation. Monitoring stations included two SPM's, one with a 1-90ppb range and a second with 50-1500ppb. Weather data, temperature, relative humidity, wind speed and wind direction, were also collected on most of the farms where monitoring took place. Results show that the agitation and removal activity significantly increase the H₂S concentrations downwind from the swine barns. Results also tell us the weather conditions measured play a significant role in the transport of H₂S downwind from the swine barns. On average, most H₂S concentrations dropped significantly or were below 30ppb at 30.4m and beyond. The drop of H₂S concentrations below 30ppb occurred prior to the end of agitation and up to five hours post agitation. Peak H₂S concentrations at 15.2m were measured an average

of 3.2 h after the start of agitation and ranged from 0-8 h. The maximum total number of 30-min average measurements greater than 30ppb for all sites was an average 5 times and ranged from 3 to 9 times.

Key Words: hydrogen sulfide, swine, manure

339 N- vs. P-based manure nutrient management: A field study of leaching losses of N and P. J.D. Toth*, Z. Dou, J.D. Ferguson, D.T. Galligan, and C.F. Ramberg, *University of Pennsylvania, Kennett Square.*

Manure applications to croplands have traditionally been made to meet plant requirements for N, which often leads to overapplication of P and elevated P runoff loss. A P-based manure application criterion has been proposed to address this concern. We initiated a field experiment in 1998 to examine leaching losses and soil accumulation of N and P with corn, alfalfa, and orchardgrass receiving N- vs. P-based dairy manure; the crops also received two additional treatments: control (no N or P added) and fertilizer (N applied at rates meeting crop requirements). Passive capillary wick lysimeters were installed underneath the replicated crop strips to collect leachate moving below the crop root zones. Leachate water samples were analyzed for nitrate and P. In the initial year of this long-term study (April 1998-March 1999), flow-weighted annual leachate nitrate-N concentrations from corn and orchardgrass were highest for the fertilizer treatment (23 and 13 mg/L, respectively) and lower for the manured treatments and the control, although these differences were not statistically significant at the 5% level. Mass of nitrate-N lost in leachate was 123 and 57 kg/ha for the fertilizer treatments to corn and orchardgrass, respectively, averaged 88 and 40 kg/ha for the manured treatments of the two crops, and 66 kg/ha for manured alfalfa. Leachate P concentrations from alfalfa were significantly higher for the N-based manure treatment (0.09 mg/L) than for P-based (0.04 mg/L). From April 1999 through January 2000 in the second year of the study, nitrate-N concentrations in leachate below the N- and P-based manure treatments were 19 and 22 mg/L for corn; and 22 and 28 mg/L for alfalfa, respectively. Nitrate-N concentrations from grass did not exceed 8 mg/L. Leachate concentrations and mass in leachate of nitrate and total

P from corn and orchardgrass generally have not differed as a result of basing manure application rates on crop N vs. P needs.

Key Words: Nutrient Management, Nitrate Leaching, Phosphorus

340 A new tool to help with sire selection. A. Perkins*², V. LaVoie¹, and J. Stellflug¹, ¹USDA ARS US Sheep Experiment Station, Dubois ID, ²Carroll College, Helena MT.

Variation in sexual performance of male mammals can be costly to producers if poor sexual performance sires are selected. Our goal was to develop a drug test that could distinguish between high and low sexual performance males before their use in production. Testosterone is necessary for male sexual behavior, but baseline concentrations are not predictive of libido. Our hypothesis was that when a ram is given an injection of naloxone his testosterone (T) and LH response to the injection can predict his sexual performance. Three experiments were conducted. Variables included dosage of naloxone, season of year, and repeatability within individual rams. Rams previously identified by behavior tests (sexually inactive[asexual; n = 26] and sexually active[n = 26]rams) were treated with naloxone(0.5, 0.75, and 1.5 mg/kg body weight)in November, June, and December. Changes in T and LH were calculated by subtracting prenaloxone average values from postnaloxone values for each ram. The largest difference was considered an individual's response to treatment. Responses to naloxone were compared between ram groups (asexual and sexually active rams) over seasons, years, and dosages using PROC GLM and PROC MIX for repeated measure. The T response to naloxone was greater (P < 0.05) in sexually active than in asexual rams, and LH response tended (P < 0.07)to differ between sexually active and asexual rams. All dosages were equally effective during the breeding season. In general, greatest values for LH and T were at 15 and 60 min after naloxone, respectively. The same rams were tested over two breeding seasons. Year affected responses (P < 0.05) but ram class x year was not significant. Accuracy of predicting asexual rams was 73% and accuracy of predicting sexually active rams was 81%. This test is most effective during the breeding season. We suggest that a refinement of this patent pending protocol be developed for veterinarians and producers to use during routine examination of potential sires.

Key Words: Sexual, Breeding, Naloxone

DAIRY FOODS

341 Rheological properties of high fat creams containing added whey proteins and homogenized at different pressures. S. Adapa and K. Schmidt*, *Kansas State University, Manhattan.*

Dairy creams with milk fat levels of 50% and 55%, were compared to study the effect of added whey proteins and homogenization pressures on the rheological behavior. The study was done in two steps. In the first study, whey protein concentrate was added to the creams (50 & 55% fat) at the rate of 0 (control), 1, 2, and 3% (w/w), UHT treated, stored at 4°C and 25°C, and evaluated over a period of 43 days. In the second study, whey protein concentrate was added to the creams (50 & 55% fat) at 2% (w/w) level, UHT treated, homogenized at 0 (control), 500, 1000, and 1500 psi, and evaluated over a period of 43 days. All creams were tested for viscoelastic properties by dynamic testing involving sinusoidal oscillatory tests at frequencies ranging from 1-10 Hz and a strain of 0.7%, using a parallel plate geometry. In both the studies, storage modulus (G') and loss modulus (G'') of all treatments were slightly dependent on frequency, exhibiting higher values at higher frequencies. In all treatments, G' was significantly higher than the G'' throughout the frequency range tested without any crossover. G' and G'' increased significantly over time and also exhibited higher values at lower temperatures (4°C). $\tan \delta$ values (G''/G') did not change over time. In the first study, level of fat resulted in differences in G' and G'' rather than the level of added protein. In the second study, homogenization pressures resulted in differences in G' and G'' values with samples homogenized at higher pressures having higher G' and G'' values but lower $\tan \delta$ values.

Key Words: Creams, UHT, Viscoelastic

342 The concentration of FFA and free amino groups in raw milk from cows fed high or low amounts of concentrate. H. Alkanhal*, M. Alshaiikh, M. Salah, and H. Mogawer, ¹King Saud University, Riyadh, Saudi Arabia.

Milk lipase activity, initial concentration of FFA and free amino groups and subsequent lipolysis and proteolysis were measured in raw milk from cows fed either high (70%) or low (40%) amounts of concentrate. Lipase activity (2.36 μeq /ml/h) and initial FFA concentration (0.26 meq/100 g of fat) were higher in raw milk from cows fed high amounts of concentrate than those in raw milk from cows fed low amounts of concentrate (2.04 μeq /ml/h and 0.14 meq/100 g of fat, respectively). Spontaneous lipolysis at 24 and 48 h was also higher in raw milk from cows fed high amounts of concentrate than in raw milk from cows fed low amounts of concentrate. Initial content of free amino groups (2.12 mmol/100 g of protein) and subsequent proteolysis at 48 h (2.28 mmol/100 g of protein) were higher in raw milk from cows fed a high concentrate ration than those in raw milk from cows fed a low concentrate ration (1.99 and 2.14 mmol/100 g of protein, respectively). Some differences in lipolysis and proteolysis in raw milk were observed between weeks of treatment. Increased lipolysis and proteolysis products in raw milk from cows fed a diet high in concentrate may increase the rate of off-flavor appearance in milk and dairy products.

Key Words: Lipolysis, Proteolysis, Concentrate

343 Effect of lipids supplementation in the ration on production of conjugated linoleic acid (CLA) and milk fat composition of dairy cows. F.L. Santos*, R.P. Lana, M.T.C. Silva, S.C.C. Brandao, and L.H. Vargas, *Universidade Federal de Viçosa, Viçosa-MG, Brazil.*

The objective of this work was to verify the effects of lipid sources (whole soybean meal and soybean oil) added to the diet on the fatty acids profile of milk fat, specially in the increasing of CLA. Six multiparous 7/8 Holstein-Zebu cows, 30 days after calving, with average body weight of 500 kg and average milk production of 20 l/day were used. The animals were divided in three groups to receive the diets (treatments), all isoproteic and isocaloric, where the control diet had 3 percent ether extract in total dry matter and the others 7 percent. The treatments containing supplementary lipids, compared to the control, decreased the percent of short chain fatty acids ($P < 0.01$) and decreased the content of butyric, caproic, caprylic, capric, lauric, myristic and the percent of saturated fatty acids ($P < 0.05$). There was still a trend for reduction in the content of palmitic and palmitoleic acids and a trend for increase in the percent of unsaturated fatty acids and long chain fatty acids ($P < 0.10$). For other side, supplementary lipids increased stearic acid ($P < 0.05$) and tended to increase the oleic acid and CLA ($P < 0.10$). The soybean oil, compared to the whole soybean meal, decreased the content of linoleic and linolenic acids and increased the CLA ($P < 0.01$), tended to increase the content of not identified fatty acids and tended to decrease the saturated fatty acids ($P < 0.10$). Concluding, the soybean oil, and not the whole soybean meal, to reach 7% lipid in the diet of milking cows, increases the content of CLA in the milk fat.

Key Words: Conjugated linoleic acid, Milk fat, Supplementary fat

344 Properties of docosahexaenoic acid enriched milk, Cheddar cheese and butter. H. Wang* and A. Hill, *University of Guelph, Ontario, Canada.*

Physical, chemical, sensory and processing properties of docosahexaenoic acid (DHA) enriched dairy products (milk, Cheddar cheese and butter) were investigated. DHA enriched milk was obtained by feeding fish meal supplement to Holstein cows. DHA level in the milk was increased to 0.4% of total fatty acids, while the total fat level in the milk was reduced to 2.43% due to fish meal's inhibition effects on fat synthesis. As drinking milk, no difference was found between DHA milk and control milk in terms of color, flavor and stability. Cheddar cheese made from DHA enriched milk ripened faster after three months of ripening and developed a more desirable texture and stronger Cheddar flavor. The yield efficiencies for DHA enriched and control cheese, 94.4 ± 2.44 and 96.4 ± 2.26 , respectively, were not significantly different ($p < 0.05$). Relative to controls, average fat globules size was smaller in DHA milk and churning time of DHA cream was longer. DHA butter showed a softer texture and better cold spreadability and butter oils from DHA enriched milk had a lower dropping point compared with control butter oil (32.89 versus 34.06°C). The result of this study showed the feasibility of producing DHA enriched dairy products, such as pasteurized milk, Cheddar cheese and butter, from DHA enriched milk obtained by feeding lactating cows with fish meal supplement.

Key Words: DHA, Docosahexaenoic Acid, Functional Dairy Products

345 Influence of feeding cows fish oil, extruded soybeans, or their combination on the composition of milk, cream, and butter. N. Ramaswamy*, R. J. Baer, D. J. Schingoethe, A. R. Hippen, L. A. Whitlock, and K. M. Kasperson, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Milk was collected from eight multiparous Holstein and four multiparous Brown Swiss cows, which were randomly distributed into four treatments in a replicated 4×4 Latin square design with 4 week per period. The four treatments consisted of a control diet (C) with a 50:50 ratio of forage to concentrate, a C diet with 2% added fat from menhaden fish oil (FO), a C diet with 2% added fat from extruded soybeans (ES), and a C diet with 1% added fat from menhaden fish oil and 1% added fat from extruded soybeans (FOES). Milk fat content from the C, FO, ES, and FOES treatments were 3.31, 2.56, 3.47, and 2.94%, respectively. Treatment milks were processed into cream and butter. Raw milk and butter from FO and FOES treatments had a four-fold increase ($P < 0.05$) in the concentration of cis-9 trans-11 isomer of conjugated linoleic

acid when compared to the C treatment, and a two-fold increase ($P < 0.05$) when compared to the ES treatment. Butter made from the ES treatment was the softest. A 300 person consumer survey comparing the C and FO milks found no difference in milk flavor.

Key Words: Conjugated Linoleic Acid, Milk, Butter

346 Storage stability of frozen sheep milk. S.L. Rauschenberger*, B.J. Swenson, and W.L. Wendorff, *University of Wisconsin, Madison.*

Sheep milk is produced only on a seasonal basis, so the possibility to produce sheep milk products year-round lies on the ability to freeze large quantities of milk while maintaining the quality of fresh milk. Fresh sheep milk was divided into two portions, frozen, and stored at two different temperatures, -15°C and -27°C . Over a one-year period, samples were removed every three months, thawed, and analyzed for coliform count, standard plate count, acid degree value, and protein destabilization. Results showed that freezing at -15°C was not adequate for maintaining stability throughout the storage period. In the samples stored at -15°C protein precipitated between six and nine months while no precipitation occurred in the samples stored at -27°C . Samples at both temperatures showed a decrease in coliform and standard plate counts. Acid degree values were significantly higher after six months of storage at -15°C than at -27°C . Various pre-freezing treatments were performed on the whole milk to evaluate their effect of protein stability of samples stored at -15°C . This included lactose hydrolysis (50%), a heat treatment ($68^\circ\text{C}/25$ min), and the addition of sodium hexametaphosphate (4 g/L). At 1, 3, 6, 9 and 12 months of storage, the samples were removed and analyzed for acid degree value and protein destabilization.

Key Words: Sheep, Milk, Frozen

347 Effect of shelf-life and light exposure on acetaldehyde concentration in milk packaged in HDPE and PETE bottles. M. Van Aardt*, S.E. Duncan, D. Bourne, J.E. Marcy, T. Long, and C.R. Hackney, *Virginia Tech, Blacksburg.*

Whole milk (3.25% milkfat) was packaged in clear glass, high density polyethylene (HDPE), clear polyethylene terephthalate (PETE), clear PETE with UV barrier, and amber PETE containers and exposed to fluorescent light at 1100-1300 lux (100-120 FC) for 18 days at 4°C . Two levels of light exposure (light-exposed or light-protected) were evaluated for each packaging treatment. Control (glass) and treated milks were evaluated by sensory and instrumental methods on day 0, 7, 14, and 18 of storage. Intensity of oxidation, acetaldehyde, and lacks freshness off-flavors was determined by eight experienced panelists. No significant difference was found in acetaldehyde off-flavor between bottle treatments (exposed or protected). The concentration of acetaldehyde that developed over time in any of the containers also never exceeded flavor threshold levels for acetaldehyde in milk. In light-exposed samples, oxidation off-flavor was significantly less when packaged in amber PETE versus the other containers. Milk packaged in HDPE containers also showed a significantly higher level of oxidation off-flavor on day 7 and 18 than milk packaged in PETE containers with UV block, but not from clear PETE or glass containers. Lacks freshness off-flavor increased over time, as expected, in light-exposed and light-protected bottles and was more intense in the light-exposed containers over the first fourteen days. Instrumental analysis (solid phase microextraction gas chromatography) showed increases in compounds associated with light oxidized flavor (acetaldehyde, pentanal, dimethyl disulphide (DMDS), and hexanal) in light-exposed samples over time.

Key Words: Acetaldehyde, Oxidation, Polyethylene terephthalate

348 Rheological properties of aging Monterey Jack goat cheese. D. L. Van Hekken*¹, M. H. Tunick¹, and Y. W. Park², ¹USDA, ARS, ERRC, Wyndmoor, PA, ²Agric. Res. Station, Fort Valley State University, GA.

There is a variety of characteristics that define goat cheese quality that needs to be identified and measured. We used different rheological methodologies to characterize the texture of Monterey Jack goat cheese as it aged. Two lots of high moisture Monterey Jack cheese (43.4 and 45.8% moisture) were manufactured at the university's dairy processing facilities. The rheological properties were analyzed after 1, 4, 8, 16, and 26 weeks of storage at 4°C . Cheeses were assayed for meltability and

their rheological properties were determined using torsion, small strain dynamic, and texture profile analyses. All cheeses decreased in hardness and tended to increase in meltability and springiness with storage. Rheological properties measured using torsion and small strain dynamic analyses changed the most within the first two months of storage, then remained fairly constant. As the cheese aged, the samples became softer with decreased hardness, shear stress, and shear rigidity; more elastic with increased elastic modulus; and more viscous with increased viscous modulus and complex viscosity. Texture mapping of torsion data indicated that the cheese became more rubbery as it aged. Rheological properties were influenced by the moisture content of the cheese.

Key Words: Goat Cheese, Rheology, Texture

349 Electrophoretic characterization of aging Monterey Jack goat cheese. D.L. Van Hekken*¹ and Y.W. Park², ¹USDA, ARS, ERRC, Wyndmoor, PA, ²Agric. Res. Station, Fort Valley State University, GA.

Monitoring the proteolysis in cheese is one way to define and characterize cheese. We used SDS- and urea-PAGE to study the protein profiles of Monterey Jack goat cheese over 6 months of storage. Two lots of Monterey Jack goat cheese were manufactured at the university's dairy processing facilities. Proteins were extracted for electrophoretic analyses after 1, 4, 8, 16, and 26 weeks of storage at 4°C. Samples were homogenized in either Tris-SDS or urea buffers, centrifuged, filtered, and the supernatant lyophilized. The urea preparation included a two hour incubation at 37°C after homogenization and required overnight dialysis before lyophilizing. Extracts were prepared for SDS- or urea-PAGE and separated using the PhastSystem. Stained gels were scanned and the protein profiles quantified using a densitometer. As expected with goat cheese, protein profiles showed that beta-casein was the major protein present, followed by alpha_{S2}-, kappa-, para kappa-, and alpha_{S1}-caseins. With aging, casein bands decreased or disappeared and peptide bands appeared. Samples, prepared using urea and incubated for 2 hours at 37°C, had more peptide bands, an indication that more proteolysis occurred in these preparations. After 6 months of aging, very little or no alpha_S-, kappa-, or para kappa-casein remained and over 40% of the beta-casein had disappeared. SDS-PAGE, which separates proteins based on molecular mass, produced profiles with twice as many peptide bands than profiles produced using urea-PAGE, which separates proteins based on charge/mass ratio. The protein profiles obtained in this study show the proteolysis of beta-casein that is unique to goat cheese and will help in identifying the protein characteristics of quality goat cheese.

Key Words: Electrophoresis, Goat Cheese, Proteolysis

350 Evaluation of sensory and chemical properties of Manchego cheese manufactured from ovine milk of different somatic cell levels. J.J. Jaeggi*¹, K.B. Houck¹, M.E. Johnson¹, R. Govindasamy-Lucey¹, B.C. McKusick², D.L. Thomas², and W.L. Wendorff², ¹Center for Dairy Research, University of Wisconsin-Madison, ²University of Wisconsin-Madison.

As ovine milk production increases in the United States, somatic cell count (SCC) is increasingly used in routine ovine milk testing procedures as an indicator of flock hygiene and health. Ovine milk was collected from one hundred and fifteen East Friesian-cross ewes milked twice daily. The milk was segregated and categorized into three different average SCC per ml: 6.10 X 10⁴, 1.15 X 10⁵, and 2.19 X 10⁶. Milk was stored in 19 L pails, frozen at -19°C, and held for 4 months. Milk was then thawed at 7°C over a two-day period before pasteurization. Casein decreased with increasing SCC levels from 3.99, 3.97, to 3.72%. Casein to true protein ratio decreased with increasing SCC levels from 81.42, 79.66, and 79.32. Milk fat varied from 5.49, 5.67, and 4.86% respective to the SCC levels of 6.10 X 10⁴, 1.15 X 10⁵, and 2.19 X 10⁶. Manchego cheese was manufactured from the three different SCC lots. A licensed Wisconsin cheese maker subjectively evaluated coagulum development and firmness. As the level of SCC increased, the first signs of flocculation increased resulting in longer times to reach desired firmness for cutting. Yield at one day decreased from 16.03 to 15.97 to 15.09% with increasing SCC levels. There were no differences in cheese composition and pH. Cheeses were coated with a polymeric cheese coating and ripened at 85% humidity at 7°C over the duration of 9 months. Lower yield was attributed to lower casein and fat content of the higher SCC milk. Cheese samples were analyzed at 1 day, 3, 6, and 9 months for soluble

nitrogen and both total and individual free fatty acids. Cheese graders noted increased levels of rancidity at the higher SCC level cheeses at each of the sampling points. No differences were noted in cheese texture between the different SCC levels.

Key Words: Ovine, Manchego, Somatic cells

351 Origin and behaviour of acid phosphatase in Cheddar cheese during ripening. R. Akuzawa*¹ and P.F. Fox², ¹Nippon Veterinary & Animal Science, University, Tokyo, Japan, ²University College Cork, Cork, Ireland.

Casein is a phosphoprotein, and dephosphorylated proteins/peptides are hydrolysed at a faster rate by lactococcal proteinases/peptidases than phosphorylated proteins or peptides. The combined action of proteinases/peptidases and phosphatases may be important for cheese quality. In preliminary work, the acid phosphatases (AP) from skim milk (SM-I and SM-II), butter milk (BM) and of the cell membrane (CM) and cell wall (CW) of *Lactococcus lactis* ssp *lactis* 303 were purified or partially purified. The proteinase/peptidase activity of strain 303 on dephosphorylated casein/phosphopeptides [a mixture mainly α₂-CN (f1 - 32) and β-CN (f1 - 28)], which were hydrolysed by the AP from SM-I, SM-II, BM, CM and CW, was determined by liberated amino acids and peptides. The proteinase/peptidase released more peptides and amino acids from the phosphopeptides which had been dephosphorylated by the AP from SM-II or CM. The AP activity in the water-soluble fraction of Cheddar cheese which had been made using strain 303 as starter, decreased slightly during ripening but the total AP activity and that in the water-insoluble fraction increased slightly. The APs SM-II and CM, which were present in water-insoluble fraction, seemed to contribute to the dephosphorylation on phosphopeptides during

Key Words: acid phosphatase, cheese

352 Effect of homogenization pressure and selected additives on some physical properties of retort-processed dairy beverages. C.A. Lin* and R.L. Richter, Texas A&M University, College Station, TX.

The objective of this study was to determine the effect of sodium citrate, locust bean gum, and iota-carrageenan on retort-processed dairy beverages. Changes in particle size distribution, apparent viscosity, and creaming rate during storage were examined. Skim milk, cream, nonfat dry milk, and sucrose were mixed to make beverages with 3% milk fat, 11% milk solids nonfat, and 8% sucrose with either 0.1% sodium citrate, 0.05% locust bean gum, or 0.05% iota-carrageenan. The mixtures were heated to 70°C, homogenized at 20, 50, or 90 MPa, canned, and retorted at 121°C for 6 min. The processed products were stored at 36°C and tested after 1, 10, 20, 30 days of storage. The creaming rate decreased as the homogenization pressure was increased. This change was concomitant to the decreased particle size associated with increased homogenization pressure. The effect of homogenization pressure on Dvs became more apparent as storage time increased. The particle size increased with increased storage time for samples homogenized at 20 MPa but the particle size distribution of samples homogenized at 90 MPa did not change during storage. Samples containing locust bean gum had a slower creaming rate than samples that contained sodium citrate during storage. The viscosity was also higher in samples that contained locust bean gum and were homogenized at 20 MPa. Samples that contained iota-carrageenan and homogenized at 20 MPa had excessive viscosity and coagulated within 10 days of storage. Samples that contained iota-carrageenan and homogenized at 90 MPa were less viscous and did not gel. Samples homogenized at 90 MPa had no or little creaming or coagulation during storage regardless any of the added ingredients.

Key Words: Homogenization pressure, Stabilizers, Retorted Dairy Beverages

353 The effect of bitter flavor on the consumer acceptability of coffee flavored ice cream. L.F. Osorio* and J.U. McGregor, Louisiana State University, LAES, LSU Agricultural Center, Baton Rouge.

Fresh coffee extracts were used to manufacture coffee-flavored ice cream. A medium dark Brazil and dark Espresso roast coffee were extracted by hot pressure and cold brewing methods. Flavored ice cream mixes

were analyzed for total solids, pH, color, and apparent viscosity. A 12-member trained panel performed a triangle test to establish if there was a difference between coffee ice cream flavored before or after pasteurization. A consumer panel of 138 people was also used to evaluate the four treatments for bitterness and sweetness intensity as well as for overall preference. There were no significant differences in pH, viscosity, color and total solids. The trained panel detected significant differences between coffee ice cream flavored before and after pasteurization ($p < 0.05$). The espresso-hot pressure extracted coffee ice cream had a more intense bitter flavor and was less preferred as determined by the consumer panel ($p < 0.05$). Dairy processors should consider the potential for bitter flavor defects when selecting and processing coffee flavored dairy products.

Key Words: Bitter Flavor, Coffee Flavorings, Ice Cream

354 Acceptable usage levels of textured whey proteins in hamburger patties. A. Hale*, C. Carpenter, and M. Walsh, *Utah State University, Logan.*

Whey proteins, textured by thermoplastic extrusion, can be used as meat extenders. The objective of this research was to determine the maximum acceptable usage level of textured whey protein (TWP) in hamburger patties. Instrumental and sensory analysis were conducted on 1/4 lb patties containing 0, 30, 40 and 50% by weight hydrated TWP. All patties were standardized to 13.6% total fat. For sensory analysis, cooked samples were assigned random three-digit numbers, rotated on ballot position, and served under red lights, in an open consumer panel. Panelists were asked to evaluate samples on a nine-point hedonic scale for tenderness, juiciness, texture, flavor, and overall acceptability. In all categories, no differences ($p < 0.05$) were observed between the all beef control and patties containing 30 and 40% TWP, but the patties containing 50% TWP scored lower in texture and beef flavor. The peak force needed to break cooked patties was measured using an instrumental probe. Ten patties from each level of TWP were analyzed. There were no differences among the peak break forces of patties containing 30, 40 or 50% TWP. The peak break force was higher ($p < 0.05$) for the all beef control than for patties containing TWP. This indicates that there may be a possible difference in cohesiveness of patties containing TWP although patties made with up to 40% TWP were equally liked as the all beef control.

Key Words: Textured whey protein, Hamburger patties, Sensory analysis

355 Estimating milk density from milk composition and temperature. A. Ueda and A. Hill*, *University of Guelph, Ontario, Canada.*

Equations to estimate milk density at 4.0°C from fat, protein, and other solids (LOS) contents were developed based on data collected over a whole year from Ontario and Alberta milk producers (N=968). Density was measured using an Anton Par Model DMA 45 density meter. Fat, protein, and LOS contents were determined by Mojonner, Kjeldahl, and oven methods, respectively. Temperature of 4.0°C was chosen because milk pricing is based on the weight/volume composition of producer milk at 4.0°C. The first objective of this work was to define a model to estimate milk density from weight/weight (w/w) milk composition to provide an accurate weight/volume conversion for the purpose of milk pricing. Current procedures in all Canadian provinces (except Quebec) and many other jurisdictions, use weight/volume conversion factors (milk density values) which seriously under estimate milk components. The recommended equation is as follows: $\text{Density} = 0.8469 + 0.03820F + 0.05565P + 0.03274L - 0.01080F*P - 0.007431F*L - 0.0006358P*P - 0.009314P*L + 0.002095F*P*L$, where F is %fat(w/w), P is %protein (w/w), and L is other solids (%w/w) Weight over weight (w/w) to weight over volume (w/v) conversions of milk components employing the developed equation were compared to conversions obtained using empirical density values measured at 4.0°C. The average difference between estimated and actual w/v values was 0.000 with standard deviation of 0.002 Kg/hL. The equation could be used to provide more accurate and equitable milk pricing without the requirement for empirical measurement of milk density. Formulae were also constructed to estimate density of producer milk at temperatures of 4.0 to 40.0°C (N=792). The best model required a cubic term for temperature. Standard deviation of residuals (predicted density - empirical density) was .00023 Kg/L.

Key Words: Milk density, Weight/volume conversion, Pricing

356 Stability of vitamin A and D in skim milk delivered by beta-lactoglobulin isolated from whey. Q. Wang, J. Allen, and H. Swaisgood, *Southeast Dairy Foods Research Center, North Carolina State University, Raleigh.*

We have reported that retinyl-Celite matrix can be used for effective isolation of β -lactoglobulin (β -LG) from whey owing to its selective adsorption of β -LG. The β -LG obtained in this way has strong binding affinity for fat-soluble nutrients, such as vitamins A, D, E and K and some fatty acids, and might be used to fortify these nutrients in non-fat or low-fat foods. A substitute for oil to deliver the essential nutrients in low-fat and non-fat foods has been sought because fat-soluble nutrients have low stability without a lipid environment. Certain nutritional proteins, such as β -LG isolated from whey by bioselective adsorption, are attractive for this purpose because of their special structure and ability to reversibly bind the vitamins. The vitamins A and D in skim milk fortified by β -LG isolated by selective adsorption was determined by saponification of skim milk, extraction of the vitamins from the milk and application of an modified HPLC method to measure the stabilities of the complexes. The skim milk was fortified with vitamins A and D to 1.16 $\mu\text{g/ml}$ and 10.6 ng/ml , respectively, with vitamin-bound β -LG to match the levels required by regulation for fortified skim milk. A three-week shelf life study in one half gallon polyethylene bottle showed that both vitamins A and D remained in skim milk without measurable loss. The accuracies of the methods used to determine vitamins A and D were 3 and 6 percent, respectively, in the test period.

Key Words: vitamins A and D, beta-lactoglobulin, stability

357 Selective purification of α -lactalbumin from whey protein isolate using a peptide ligand obtained from a combinatorial library. P.V. Gurgel*, R.G. Carbonell, and H.E. Swaisgood, *North Carolina State University, Raleigh.*

Alpha-lactalbumin is a low molecular weight (14.2 KDa) globular whey protein that acts as a regulator for the enzyme lactose synthase in the biosynthesis of lactose. Because of its high digestibility and lower potential for causing allergic response when compared to beta-lactoglobulin, alpha-lactalbumin is a good candidate as an ingredient for infant formulas. In this work we report a method for purification of alpha-lactalbumin from whey protein isolate (WPI) by bioselective adsorption using ligands from a combinatorial peptide library. A 0.5 mL sample of 5.55 g/L WPI in 50 mM phosphate buffer, pH 7.0 was applied to a 0.6 mL column containing the peptide WHWRKR immobilized onto a polymethacrylate resin. The column was able to bind the target protein, and two fractions rich in alpha-lactalbumin were obtained, eluting in 0.1 M NaCl and 0.25 M NaCl, respectively. The first fraction appears to be slightly contaminated with beta-lactoglobulin and lactoferrin. The second fraction contained alpha-lactalbumin and lactoferrin. Densitometric measurements established that the concentration of alpha-lactalbumin in the original sample of WPI was 30.3%, while in the first fraction it was increased to 97.3%. Thus, the method increased the concentration of lactalbumin 3.3-fold in one step.

Key Words: Alpha-Lactalbumin, Peptide Ligands, Bioselective Adsorption

358 Fractionation of bovine transferrin from whey using immobilized gangliosides. M.K. Walsh* and S.H. Nam, *Utah State University, Logan.*

Bovine transferrin (BTF) is major-iron transport and regulator protein found in bovine whey. In order to mediate its roles in cell proliferation and differentiation, BTF must interact with eukaryotic cell surfaces. As common components of eukaryotic cell surfaces, gangliosides were used for the affinity fractionation of BTF. The objective of this research was to fractionate BTF from whey protein isolate solution using an immobilized ganglioside matrix. BTF was further purified using Con-A affinity and ion exchange chromatography. BTF was identified by SDS-PAGE and Western analysis. Gangliosides, organically extracted from bovine buttermilk, were covalently immobilized onto controlled-pore glass beads. The immobilized matrix contained 66 micrograms of gangliosides per gram beads. After loading the immobilized matrix, 2 g beads, with a 2% whey solution, the matrix was washed with sodium acetate buffer at pH 4 containing 1 M NaCl before elution of BTF with sodium phosphate at pH 7. SDS-PAGE analysis showed a 74.2% BTF recovery from whey. BTF was enriched to 24% and 61% purity with

Con-A affinity and ion exchange chromatography. The Con-A affinity and ion exchange chromatography steps enriched BTF in the samples and removed other whey proteins from ganglioside purified fractions. BTF appeared in SDS-PAGE and Western analysis as a dimer of 72 and 76 kDa. These results indicate that immobilized ganglioside can be used to easily fractionate BTF from bovine whey.

Key Words: Bovine transferrin, Gangliosides, Purification

359 Fractionation of peptide mixtures from β -lactoglobulin enzymatic hydrolysate by means of isoelectric focusing. P.E. Groleau^{*1,2}, Y. Pouliot¹, S.F. Gauthier¹, and R. Jimenez-Flores², ¹Centre de recherche STELA, Université Laval, Québec City, Canada, ²Dairy Product Technology Center, California Polytechnic State University, San Luis Obispo.

Enzymatic hydrolysis improves nutritional and functional properties of dairy proteins. Protein hydrolysates often have to be fractionated to obtain peptides with higher functionality or better nutritional value in a more purified form. The fractionation of peptide mixtures can be achieved by nanofiltration (NF), a separation technique using charged membranes. However, the occurrence of peptide-peptide attractive/repulsive interactions in the mixtures will have an impact on NF fractionation since these interactions affect the charge/mass distribution within the peptide mixture. The objective of this study was to investigate the use of isoelectric focusing (IEF) for the separation of a peptide mixture from a tryptic hydrolysate of β -lactoglobulin, in order to identify peptide-peptide interactions. IEF was performed on a Rotofor cell (Bio-Rad) using the peptide mixture without added ampholytes, so that the amphoteric nature of the peptides would generate the pH gradient for their resolution, based on the isoelectric point (pI) of each peptide. IEF fractionation of the peptide mixture led to 20 peptide fractions having a pH value from 2.5 to 11.6. The results showed that most peptides in the hydrolysate have their pI between pH 4 and 7, and few around pH 11 (10%). Methanol (25%) influences the pH gradient generated. All the fractions were analyzed by RP-HPLC (C18 column) for characterization of its peptidic content. Each peptide fraction was also suspended in phosphate buffer (pH 2.5, 0.1 M) and further separated using capillary electrophoresis (CE) with and without dissociating agents (Urea, DTT) in order to minimize peptide-peptide interactions. Preliminary results showed that urea (1M) has no effect on the electrophoregrams while DTT (70mM) changes only the profile of the fractions having low pI (pH 4).

Key Words: β -lactoglobulin, Peptides, isoelectric focusing

360 Effect of hydrodynamic conditions on the fractionation of a β -lactoglobulin peptide mixture by nanofiltration membranes. J-F. Lapointe*, Y. Pouliot, and S. F. Gauthier, Centre de recherche STELA, Québec, Canada.

The fractionation of a β -lactoglobulin peptide mixture of by nanofiltration (NF) membranes has been investigated. Enzymatic hydrolysates were prepared by tryptic (TH) hydrolysis of commercial β -lactoglobulin followed by UF treatment using a 10 000 g.mol⁻¹ MWCO membrane in order to remove the enzyme and non-hydrolyzed material from the reaction mixture. The peptide mixture, which was adjusted at pH 9.0, was further fractionated using a SG13 (Osmonics, Minnetonka, MN) cellulose acetate NF membrane with a molecular weight cut-off (MWCO) of 2500 g.mol⁻¹. The effect of hydrodynamic parameters was studied by including a total of 16 condition combinations in a complete random design: duration of the filtration (30 and 120 min), recirculation rate (1.5 and 2.5 L.min⁻¹), transmembrane pressure (200 and 500 kPa) and peptide concentration (1 and 5 g.L⁻¹). All the experiments were performed in triplicate on a 2L peptide solution using a SEPA-CF plate and frame module (Osmonics) in a full recycle mode at 40°C. Permeation rate (L.min⁻¹) was measured at 15 min intervals during the filtration and 25 mL permeate aliquots were collected at the end of each trial for further analysis of nitrogen transmission and peptide distribution by reverse phase chromatography (RP-HPLC). Preliminary results show that in high peptide concentration (5 g.L⁻¹) conditions, both recirculation rate and transmembrane pressure have an important effect on the membrane selectivity for acid and basic peptides. These results suggest that the control of the hydrodynamic conditions used in NF, in regard of the

polarization concentration layer, can potentially modify the selectivity of peptide fractionation.

Key Words: Nanofiltration, Peptide fractionation, Enzyme specificity

361 Modification of rheological properties of whey protein isolate through limited crosslinking with microbial transglutaminase immobilized on porous glass. C.P. Wilcox* and H.E. Swaisgood, North Carolina State University, Raleigh.

The desire of the food industry to convert waste products into value-added, high-priced commodities has inspired a growing interest in the development of processes for the enhancement of whey protein functionality. Physical and chemical methods commonly used for this purpose include thermal treatment and acid hydrolysis. Enzymatic methods are also utilized but are often disregarded due to the cost of continuous replacement of enzyme. Microbial transglutaminase (mTG), which forms isopeptide bonds in proteins, is distinct from its mammalian counterpart in that it is smaller, more stable, and is calcium independent. We developed a process by which mTG was immobilized to a glass bead matrix allowing for limited crosslinking of whey protein isolate. Biotin was covalently bound to 10 mL of controlled-pore glass, followed by adsorption of avidin. The enzyme was then biotinylated using NHS-LC biotin during which there was no significant reduction in activity. An 8% solution of whey protein isolate (WPI) was prepared in 50 mM sodium phosphate containing 2 mM dithiothreitol and 2 mM calcium chloride, pH 6. The WPI was then recirculated over the beads for one to four hours immersed in a water bath held at 40°C. Crosslinked WPI was tested for viscosity using a temperature ramping protocol. Gelation properties were analyzed using a StressTech rheometer. Samples were brought to the desired denaturation temperature, held for 18 min, and cooled to room temperature for gel formation. Small-strain oscillatory measurements were taken to determine gel strength and elasticity. When compared with native WPI, crosslinked WPI exhibited greater viscosity and distinctive gel characteristics. This process allows for recycling of the enzyme, eliminates the requirement for a downstream inactivation step, and permits the precise control over the extent of crosslinking. The functional properties of WPI were repeatedly modified using the same reactor, illustrating the capacity of immobilized enzymes to be used more frequently in applications of this nature.

Key Words: Transglutaminase, Immobilization, WPI

362 Study of protein-polysaccharide interactions, using whey protein-dextran systems. G. Lemay* and S. L. Turgeon, Dairy Research Center, Laval University, Québec, Canada.

The food we eat every day is mainly made of proteins and polysaccharides. These biopolymers play a major role in the stability and structure of our food products. The study of protein-polysaccharide interactions is therefore essential to the understanding and prediction of food behavior. In aqueous solution, proteins and polysaccharides interact to form co-soluble, incompatible or complex systems. The behavior of a whey protein isolate (WPI) with a neutral or anionic dextran (ratio 10:1; 5:1; 2:1; 1:1; and 1:2) was studied by phase diagrams at pH 5.2 and 7.0. When incompatibility and phase separation occurred, the partition of each phase was identified and quantified by means of polysaccharide and protein dosage using the phenol-sulfuric and the Kjeldahl methods. These dosages revealed that the dextran was found in the superior phase with most of the solvent whereas the WPI was found to be concentrated in the inferior phase. The effects of the different ratios of WPI-dextran sulfate, pH and the presence of NaCl on the WPI behavior was also studied by differential scanning calorimetry (DSC). Dextran sulfate added to WPI seems to have a protective effect on its denaturation temperature and to raise it up by 3 to 7 degrees Celsius. Adding NaCl had a similar effect but adding simultaneous NaCl and dextran sulfate had no additive effect. In this case, only the effect of the salt prevails. This study gave us a better understanding of the behavior of protein-polysaccharide systems and confirmed the electrostatic nature of the WPI-dextran interactions. Further studies of these systems would be interesting to demonstrate the stabilizing role dextran can play in real food systems.

Key Words: Whey Protein Isolate, Dextran and Dextran Sulfate, Protein-Polysaccharide Interactions

363 Interactions between diatomites or synthetic silicates and calcium phosphocaseinate: effect of adsorbent properties. N. Martin^{*3}, Y. Pouliot¹, R. Jimenez-Flores², M. Britten³, and P.S. Tong², ¹Centre de Recherche en Sciences et Technologie du Lait, Ste-Foy, Quebec, Canada, ²Dairy Products Technology Center, San Luis Obispo, California, ³Food Research and Development Center, St-Hyacinthe, Quebec, Canada.

The ability of diatomite Celite[®] 512, synthetic magnesium silicate Celkate[®] T21 and synthetic calcium silicate Silasorb[®] to modify the casein ratio of calcium phosphocaseinate was under investigation. The adsorption treatments were made by mixing 10% of these adsorbents with calcium phosphocaseinate solution (5% total protein) for 30 minutes under constant agitation. Centrifugation was used to separate the adsorbents from the treated solution. Magnesium silicate showed the higher adsorption capacity of all the adsorbents with 13.69g protein per 100g adsorbent. The ratio of caseins to proteins other than caseins was increased from 7.80, in untreated calcium phosphocaseinate, to 17.86 after treatment with this adsorbent. The enrichment in caseins may be explained by the specific affinity of magnesium silicate for whey proteins. The ratio between casein fractions was also affected by treatment with magnesium silicate because of its ability to bind β -caseins more specifically. Calcium silicate and diatomite adsorption capacities were much lower than magnesium silicate with 5.00 and 1.15g protein per 100g adsorbent respectively. Adsorption treatments with both calcium silicate and diatomite enabled the enrichment of calcium phosphocaseinate in α -caseins and α -lactalbumins but to different extents depending on the adsorbent used. Moreover, calcium silicate seemed able to specifically remove components other than proteins. In order to get a further comprehension of the adsorbents behaviour, the determination of the active sites at their surface, concurrently with titration analysis were made. The results allowed us to make hypothesis on the chemical and physical state of the adsorbents in aqueous media. However, each adsorption behaviour could not be fully explained only by using results from surface characterization.

Key Words: Calcium phosphocaseinate, Adsorption treatments, Active sites

364 Influence of fractionation sequence and filtration temperatures on the physical and chemical properties of milk fat fractions. K.E. Kaylegian^{*1}, ¹Wisconsin Center for Dairy Research, Madison.

Milk fat fractions were produced using 3 lots of commercial anhydrous milk fat, in a total of 8 production cycles, each consisting of 2 to 5 fractionation steps. Milk fat fractions were produced on a pilot scale (50 kg) using the Tirtiaux crystallization process and separated with pressure filtration (3 bar). The number of fractionation steps and filtration temperatures were varied to obtain fractions with the most value as food ingredients. Other processing parameters (e.g., cooling profiles and agitation rates) were set to obtain well-formed, filterable crystals, with sufficient yields. First step fractions were obtained at 28, 26, and 21°C, second step fractions at 18, 17, 15, and 12°C, third step fractions at 12, 10, 9, and 8°C, fourth step fractions at 11 and 8°C, and fifth step fractions at 10, 9, and 8°C. The liquid fraction at each step was generally refractionated to improve the yield of the lowest melting fraction in the sequence. Fractions were characterized for yield, dropping point, solid fat content profile, fatty acid composition, and triglyceride composition. The first step solids were all very high melting fractions regardless of filtration temperature. The second step solids were either high or middle melting fractions, depending on the temperature sequence used. Solid fraction obtained at the third through fifth steps were middle or low melting fractions. Distinct difference in properties were observed for fractions filtered at 15 compared with 12°C. Yet, fractions obtained at 11 or 12°C showed similar properties whether they were obtained at the second, third or fourth steps. The differences observed between these fractions were consistent among production cycles, milk fat lots, and the number of fractionation steps used. To obtain a good quality very low melting fractions, a minimum of three steps were required. Processing was easier and fraction characteristics were better when the previous step had a filtration temperature no greater than 12°C.

Key Words: Milk fat, Fractionation, Milk fat fractions

365 Low cholesterol Mozzarella cheese obtained from homogenized and beta-cyclodextrin-treated milk. H. S. Kwak^{*}, C. G. Nam, and J. Ahn, *Sejong University, Seoul, Korea.*

The effects of homogenization conditions and β -cyclodextrin (β -CD) on cholesterol removal of Mozzarella cheese was examined. The homogenization pressure influenced markedly on the cholesterol removal in milk, and 75.64% of cholesterol, the highest rate was removed at 1000 psi. In addition, an increase in temperature resulted in an increase of cholesterol removal in the range of 71.75% to 78.22%. Among different concentrations of β -CD addition, 1.0% showed 78.21% of cholesterol removal. Therefore, cholesterol-reduced Mozzarella cheese was made by cheese milk treated with 1000 psi homogenization at 70°C and 1% β -CD addition for a subsequent study. In results, meltability, stretchability, and oiling off in cholesterol-reduced cheese were significantly lower than those in control. Hardness, gumminess and chewiness were significantly reduced, while cohesiveness and elasticity increased. Appearance and flavor of the cheese were superior, but texture inferior to the control. This study showed a possibility in the manufacture of cholesterol-reduced cheese by the application of β -CD.

Key Words: Cholesterol removal, Beta-cyclodextrin, Mozzarella cheese

366 Configuration of an unconventional bioreactor for milk lactose hydrolysis. A.N. Genari¹, F.M.L. Passos^{*1}, and H.E. Swaigood², ¹Universidade Federal de Vicosa, Vicosa, Brazil, ²North Carolina State University, Raleigh.

Permeabilized microbial cells can be used as a crude enzyme preparation for industrial level processes. Immobilization and subsequent reuse of the bioreactor can compensate for the low specific activity of this preparation. Alginate beads are a common support for biomass immobilization; however, this configuration has a low surface area and requires low biomass concentration for bead strength. We have designed a biocatalyst consisting of a paste of permeabilized *Kluyveromyces lactis* cells gelled with manganese alginate over a semi-circular stainless steel screen. A ratio of wet permeabilized biomass to alginate of 50:4 (w/w) resulted in a paste with maximum gel biomass retention. The biocatalyst was more stable when stored in milk at 4°C than in 50% glycerol. The unused biocatalyst stored in milk did not lose activity after 50 days. However, operational use through 40 cycles resulted in 50% loss of activity. An unconventional bioreactor for milk lactose hydrolysis was designed using this biocatalyst. Semi-circular screens were stacked in a column with circumferential cuts placed alternately to permit continuous serpentine flow of milk through the column, thus producing maximum contact between the milk and biocatalyst surface during the hydrolysis process. The bioreactor was operated as a packed bed or with recirculation (essentially a CSTR) at 40°C. The maximum activity was observed when operated with recirculation. The continuous system with recirculation resulted in 82.9% lactose hydrolysis at a flow rate of 2.0 mL/min, indicating the potential of this system for processing low lactose milk. This system could be used for processing other substrates using an appropriate biocatalyst.

Key Words: Lactose hydrolysis, Immobilized cell bioreactor, *Kluyveromyces lactis* cells

367 Application of optical light microscopy to monitor air cell changes in ice cream during freezing in a batch freezer. Y.H. Chang^{*}, R.W. Hartel, and R.W. Hartel, *University of Wisconsin, Madison.*

Air cell size is one of the important aspects of ice cream structure that determines product quality. An optical light microscopy method was developed as an alternative to scanning electron microscopy to monitor dynamic air cell size changes in ice cream during freezing in the batch freezer. Effect of fat, stabilizer, and emulsifier content on the change in air cell size during freezing were studied. The effects of whipping temperature, under both freezing and nonfreezing conditions, were also studied. Air cell size decreased progressively during batch freezing. High concentration of stabilizer affected air cell size distributions at early drawing times when ice cream was still in slurry state because of higher mix viscosity. Formula changes had relatively low impact on air cell size changes in ice cream at later stage of freezing. Freezing conditions were necessary to obtain high overrun and small air cell sizes, since whipping of ice cream mix at elevated temperatures (0 and 20°C) resulted in much less overrun.

Key Words: Ice cream, Air cell, Freezing

368 Isolation and characterization of lactococcal bacteriophages infecting EPS-producing strains. H. Deveau* and S. Moineau, *Universite Laval, Quebec, Canada.*

Starter cultures used to manufacture buttermilk are composed of *Lactococcus* and *Leuconostoc* strains. The *Lactococcus* strains are mainly employed to acidify milk and to produce exopolysaccharides whereas the *Leuconostoc* strains are responsible for the flavor development. It is well documented that milk acidification can be slowed down by lytic phages. Here, we report that exopolysaccharide production can also be impaired by lytic lactococcal phages. Forty-seven buttermilk samples, containing phages, were obtained from 13 North American plants. Eight distinct lytic phages, named Q61 to Q68, were isolated from these samples and their genomes were characterized by restriction patterns (*EcoRI* and *EcoRV*). Some of these phages were isolated from only one plant (Q63, Q66 and Q68) while others were found in several plants, including phage Q64 which was present in 8 of the 13 dairy plants tested. Using a multiplex PCR method, the 8 phages were classified within the 936 species (small-isometric heads). The host range of these phages was determined on 19 *Lactococcus* strains including 7 EPS-producing and 12-acidifying cultures. Three phages attacked the mucoid strain RA whereas the 5 other phages infected only the mucoid strain UO. The five other EPS⁺ strains (H414, MLT2, MLT3, VFK, W12D) as well as the 12 acid strains were insensitive to the 8 phages. These results showed that EPS⁺ producing strains are also sensitive to phages and that these phages are members of the most dominant lactococcal phage species.

Key Words: *Lactococcus*, Exopolysaccharides, Bacteriophages

369 Identification and characterization of the anti-receptor gene of *Streptococcus thermophilus* bacteriophages. M. Duplessis* and S. Moineau, *Universite Laval, Quebec, Canada.*

Streptococcus thermophilus is a thermophilic lactic acid bacterium widely used for the production of fermented milk products such as Italian cheeses and yogurt. The manufacture of these dairy goods has risen sharply over the past years. It is known that increased productivity within existing facilities will lead to milk fermentation failures due to lytic bacteriophages. *S. thermophilus* phages are currently classified into two groups based on their number of major structural proteins (MSP) and their mode of DNA packaging. Phages with two MSP and cohesive genome extremities (cos-type) appear to be predominant. Recently, our laboratory sequenced the first complete genome of a cos-type lytic phage (DT1). Sequence analysis suggested that one open reading frame (ORF18) may be the anti-receptor protein, which is responsible for host specificity. Homologous regions were sequenced in five other cos-type *S. thermophilus* phages (DT2, DT4, MD2, MD4 and Q5). The N-terminal (494 amino acids) and the C-terminal (189 amino acids) regions were highly conserved among the six phages. The conserved regions were interspersed by a heterologous segment located in the middle of the protein. As for the lambdoid and T-even phages, the presence of conservative and non conservative regions are characteristics of anti-receptors. One to four collagen-like repeats (Gly-X-Y)_n were also found in ORF18 and they could represent recombination hot spots. A host range study was also conducted with the six phages on thirty-eight strains of *S. thermophilus*. Phages DT4 and Q5 had identical host range and ORF18 whereas the other phages had a distinct host range and ORF18. These results strongly suggest that ORF18 is the anti-receptor of *S. thermophilus* bacteriophages.

Key Words: Anti-receptor, Bacteriophages, *Streptococcus thermophilus*

370 Survivability of lactic acid bacteria and bifidobacteria in a spreadable yogurt cheese product. T. Pritchard*, M. Guo, A. Zielinski, and P. Kindstedt, *Northeast Dairy Research Center, University of Vermont, Burlington.*

A newly developed dairy-based product containing pro-biotic cultures was evaluated over an 8 week period to determine the survivability of Lactic Acid Bacteria (LAB) and Bifidobacteria (BIF) within the product. Six batches of the spreadable yogurt cheese were manufactured and evaluated at 1 week intervals. Chemical analysis of the yogurt cheese determined the product was: moisture, 75%; fat, 6.9%; protein, 12.4% and pH 4.64. Following production, the yogurt cheese was placed in plastic bags, vacuum packaged and held at 4°C. Viable LAB and BIF were enumerated via incubation under anaerobic conditions using M17 and RAF 5.1 media respectively. Analysis of the yogurt cheese revealed

an average initial inoculum of $6.36 \times 10^6 \pm 5.28 \times 10^6$ LAB and $2.57 \times 10^7 \pm 7.29 \times 10^6$ BIF. Following drainage of the curd, the LAB had increased 400 fold to 2.74×10^9 /g while the BIF increased 2 fold to 5.41×10^7 /g during the same period. Average levels of LAB remained above 2×10^9 /g for four weeks. A steady decline in viable LAB was noted from week 5 (1.8×10^9 , $\pm 3.73 \times 10^8$ /g) to week 8 (1.1×10^9 , $\pm 7.62 \times 10^8$ /g). Average levels of BIF dropped to initial inoculum levels (2.79×10^7 /g) by week 3. The number of viable BIF remained stable between weeks 4 (2.87×10^7 , $\pm 9.05 \times 10^6$ /g) and week 8 (2.21×10^7 , $\pm 9.41 \times 10^6$ /g). The results of the survey indicate that the newly developed yogurt cheese is an effective matrix in which to supply LAB and BIF to consumers. The yogurt cheese product shows promise as a means of delivering BIF at levels of 10 to 20 fold higher than that which the food industry has presently targeted (i.e. 10^6 /g).

Key Words: Lactic Acid Bacteria, Bifidobacteria, yogurt-cheese

371 Enhancement of AbiK anti-phage activity on low-copy plasmids. J. D. Bouchard* and S. Moineau, *Universite Laval, Quebec, Canada.*

Phages of lactic acid bacteria are the main cause of fermentation failures in the dairy industry. Anti-phage mechanisms can be introduced into industrial strains of *Lactococcus lactis* to limit this problem. It is expected that a phage resistance system will be fully effective in different strains and under various conditions. AbiK is a putative protein of 599 amino acids, encoded by the 7.8-kb natural lactococcal plasmid pSRQ800, that leads to abortive infection of small isometric-headed phages (EOP 10^{-6}). Upstream of the *abiK* gene, two small open reading frames of 116 (ORF3) and 94 (ORF4) amino acids are preceded by a putative promoter and followed by a putative terminator. Unlike the *abiK* gene, this operon has a G+C content similar to typical lactococcal DNA sequences. ORF4 possesses a helix-turn-helix motif and has low homology with several transcription regulators. When the three genes were cloned on a low-copy plasmid, a transcript encompassing *orf3-orf4-abiK* was detected by RT-PCR. Deletion of the ORF3-ORF4 operon or presence of ORF4 *in trans* on a high-copy vector reduced the anti-phage activity of AbiK (EOP 10^{-2}). On a medium-copy plasmid, RT-PCR indicated that *orf3*, *orf4* and *abiK* are not cotranscribed and deletion of ORF3-ORF4 had no effect on AbiK activity. Based on these results, ORF4 may act as a repressor on its promoter but only when cloned on medium- and high-copy plasmids. Under those conditions, *abiK* is sufficiently expressed from its own promoter to ensure a strong phage resistance phenotype (EOP 10^{-6}). On low-copy plasmids, *abiK* is also transcribed from the *orf3-orf4* promoter which thereby increases the efficacy of AbiK from EOP 10^{-2} to EOP 10^{-6} . Thus, surrounding genes and *cis*-acting sequences can play a role in the modulation of anti-phage activity.

Key Words: *Lactococcus lactis*, Bacteriophages, Abortive infection

372 Sensory aroma characteristics of milk spoilage by *Pseudomonas* species. W. W. Hayes*, C. H. White, P. D. Gerard, and M. A. Drake, *Mississippi State University, Mississippi State.*

A long shelf-life with consistent high quality is desired for fluid milk. *Pseudomonas* species are normally associated with fluid milk spoilage with *P. fluorescens*, *P. fragi*, and *P. putida* being the most common. By having a better insight into the spoilage characteristics of pseudomonads, detection and prevention of these organisms may be improved. The objectives of this study were: 1) to determine sensory aroma profiles of spoilage aromas for milk with varying fat contents spiked with these pseudomonads; and 2) to determine differences in growth rates at 5°C. Two strains each of *P. fluorescens* (P27 & P11), *P. fragi* (P24 & P9), and *P. putida* (P14 & P15) were evaluated. Milk (skim and whole) was double-steamed and either initially inoculated with 10^3 CFU/mL of each pseudomonad or not inoculated as a control. Milks were held at 5°C for one month. Plate counts were conducted every three days to determine growth rates. Descriptive aroma analysis was conducted weekly using a trained panel (n=8). Experiments were replicated in triplicate. All six strains grew at refrigeration temperature (5°C). Within three days of storage all treated milks had reached 10^7 CFU/mL and by the first descriptive analysis panel all treatments had reached 10^8 CFU/mL. All strains were lipolytic on spirit blue lipase agar. On skim milk agar strains P27 and P11 were proteolytic. Spoilage was detected in milks containing strains P27, P14, and P15 following one week storage, while spoilage in milks treated with strains P11, P24, and P9 was not detected

until two weeks storage. "Fruity" aromas predominated after one week spoilage. After two weeks spoilage, "cheesy", "putrid", and "barny" aromas predominated. Types and onset of spoilage differed among the strains of pseudomonads. Growth rates were not different among strains ($P < 0.05$). This information may aid in shelf-life prediction of milk.

Key Words: *Pseudomonas*, Milk, Spoilage

373 Manufacture of hard cheese inoculated with pathogenic bacteria in a Bio-Safety Level 3 pilot plant. J. E. Schlessner^{*1}, A. Teo², and D. Englehardt², ¹*Food and Drug Administration, NCFST, Summit-Argo, IL*, ²*Illinois Institute of Technology, Chicago, IL*.

The Bio-Containment lab was modified to upgrade the lab to Bio-Safety Level 3 for small scale cheese-manufacturing from raw milk inoculated with food pathogens. Environmental sampling was conducted before the experiment and after decontamination to evaluate these procedures. The finalized procedures were incorporated into the Bio-Containment Operating Manual. Initially, cheese was made from raw milk with naturally occurring *Escherichia coli* to test the cheese-making equipment, and to monitor levels during the cheese-making process, subsequent aging period, and the decontamination in the bio-containment lab. Environmental sampling of surfaces showed that no naturally occurring *E. coli* was present on the equipment after decontamination. Later, cheese was made with raw milk inoculated with *E. coli* K-12 (ATCC 35695). This streptomycin-resistant strain of *E. coli* was used to monitor levels during the cheese-making process, subsequent aging period, and the decontamination in the bio-containment pilot plant. Cheese, made with raw milk inoculated with 10^5 *E. coli* K-12, showed the surrogate was incorporated at approximately the same levels as the initial inoculum. Environmental sampling of surfaces showed that no surrogate was present on equipment after decontamination. Environmental sampling using an Anderson Air Sampler showed that no *E. coli* K-12 was present in the cubicle air or into the external environment filtered through a 0.3 micron HEPA filter. After Bio-Containment Lab and procedures were certified by an external consultant, hard cheese inoculated with 5 strains of *E. coli* O157:H7 were manufactured. Air and surface sampling showed similar results.

Key Words: Pathogenic Bacteria, Raw Milk Cheese, *E. coli*

374 Effects of incorporation of proteolytic strains of *Lactobacillus delbrueckii* ssp. *bulgaricus* in commercial ABT cultures on EPS production, textural properties of yogurt and survival of bacteria. A. Shihata and N.P. Shah^{*}, *Victoria University of Technology, Melbourne, Australia*.

Use of polysaccharide producing ABT (*L. acidophilus*, *Bifidobacterium* spp., and *S. thermophilus*) starter cultures are gaining popularity among yogurt manufacturers. Polysaccharide-producing yogurt bacteria are important determinants of yogurt viscosity and texture. These starter cultures improve the viscosity of yogurt, leading to resistance to mechanical damage. *S. thermophilus* is the main fermenting organism in ABT starter cultures. In previous studies, *S. thermophilus* in commercial ABT starter cultures was found to be much less proteolytic as confirmed by o-phthaldialdehyde-based spectrophotometric assay. Among several strains of *L. delbrueckii* ssp. *bulgaricus* screened, two strains were found to be highly proteolytic. The aim of this study was to determine the effects of incorporation of proteolytic strains of *L. delbrueckii* ssp. *bulgaricus* to ABT (ABT-LB) starter cultures on EPS production and the textural properties of yogurts. The yogurt made using commercial ABT starter cultures was used as a control. The firmness of yogurts was measured with a cone-penetrometer and the apparent viscosity with a Brookfield viscometer. EPS was extracted and quantified by phenol sulfuric method. Sugar analysis of the EPS fractions was determined by HPLC. Survival of the three (in ABT) or four (in ABT-LB) groups of bacteria was determined over a 4-week storage period. Results have shown that yogurts made with ABT-LB were the firmest and most viscous and produced the highest amount of exopolysaccharide (3g/100g) as compared with those prepared with ABT starter cultures. The EPS fractions extracted from yogurt samples composed mainly of galactose and glucose. Viable counts of *S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus*, *L. acidophilus* and *Bifidobacterium* spp. improved by over

2 log cycles in yogurts made with ABT-LB starter cultures during 4 weeks storage period.

Key Words: ABT starter cultures, EPS, Texture properties

375 Casein and whey proteins degradation patterns by selected lactic bacteria. A. Shihata and N.P. Shah^{*}, *Victoria University of Technology, Melbourne, Australia*.

Caseins and whey proteins are the main nitrogen source for yogurt bacteria *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* and probiotic bacteria *L. acidophilus* and *Bifidobacterium* spp. These bacteria utilize caseins and whey proteins with the help of extra-cellular proteinases and membrane bound amino-peptidases as well as intracellular proteinases and peptidases. The objective of this study was to investigate caseins and whey proteins degradation patterns by selected yogurt and probiotic bacteria. Capillary electrophoresis (CE) was used for analysis of milk protein degradation patterns owing to its advantages over electrophoresis and chromatographic methods. Sterile reconstituted skim milk (RSM) was inoculated with individual strains of yogurt and probiotic bacteria and incubated for 6 h. Samples were withdrawn and levels of hydrolysis of various caseins and whey proteins determined. CE was carried out using a Beckman P/ACE system 5010 with a Gold Software data system version 810. The separations were performed using a hydrophilic-coated fused silica capillary column. Complete amino acid analyses of RSM before and after 6 h incubation with individual bacterium were also carried out. The proteolytic enzyme profiles of the bacteria, particularly their amino-, di-, tri-, and endo-peptidases were determined. Yogurt bacteria possessed higher levels of proteolytic enzymes than probiotic bacteria and the extent of degradation of caseins and whey proteins by yogurt bacteria was much higher. The patterns of caseins and whey proteins hydrolysis varied with the strain and the organisms showed no definite trend. Yogurt bacteria released higher levels of free amino acids and demonstrated greater amino peptidases and di-peptidases activities than probiotic bacteria. Both groups of bacteria utilized aspartic acid, glutamic acid, leucine and lysine from RSM, whereas appreciable amounts of cystine and cysteine were detected in RSM after 6 h incubation. The levels of cysteine and cystine were higher in RSM after incubation with probiotic bacteria than when inoculated with yogurt bacteria.

Key Words: Protein degradation, Lactic bacteria, Proteinases

376 Quantitation of a proteinase secreted by a strain of *Pseudomonas fluorescens* using rocket immunoelectrophoresis. A. Zahran^{*1} and B. Ward², ¹*Minia University, Egypt*, ²*University of Edinburgh, UK*.

Rocket Immunoelectrophoresis (RIE) constitutes a simple method for quantitating protein based on the cross reaction between antigen and antibodies raised against the enzyme. RIE technique was used to monitor the synthesis of proteinase protein during growth in glucose basal medium in the presence and absence of calcium chloride. Measurement of protein synthesis rather than enzyme activity was very sensitive and enzyme protein could be detected down to 45ng. Preliminary work showed that the quality of the antibodies raised against the enzyme when mice were used was better than using rabbit antibodies. *Pseudomonas fluorescens* R8 synthesized a constitutive enzyme as protease synthesis was not greatly affected by the presence of proteins or protein degradation products in the medium. The enzyme was synthesized at the early stages of growth and was detected in the glucose basal medium. The amount of proteinase secreted in complex medium was between 2.6-2.8 fold higher compared to the enzyme produced in basal medium with either glucose or glutamate in the presence of calcium chloride.

Key Words: *Pseudomonas fluorescens*, Proteinase, Immunoelectrophoresis

377 Purification and characterization of a heat stable proteinase secreted by *Pseudomonas fluorescens* R8. A. Zahran^{*1} and B. Ward², ¹*Minia University, Egypt*, ²*University of Edinburgh, UK*.

An extracellular protease from *Pseudomonas fluorescens* R8 was purified to electrophoretic homogeneity in three steps. This protease was a major component in the culture supernatant. Two peaks were eluted after ion exchange chromatography. Peak A contained about 60% of

the total activity whereas peak B contained about 15%. The two peaks were found to have the same molecular weight (45K daltons) and their immunochemical identity has been determined. Characterization of peak A showed it to be a metallo-alkaline protease which contained calcium and zinc. The enzyme had an optimum temperature around 40°C and optimum pH = 7.5. The activity of the protease was inhibited by o-phenanthroline, EDTA and EGTA. It was more sensitive to o-phenanthroline than EDTA and EGTA. The amino acid composition showed that the enzyme contained high levels of aspartic acid and glycine but lacked cysteine. The total carbohydrate content was very low revealing that the protease was not a glycoprotein. The protease was heat stable, the D-value at 140°C was 1 min. and 28% of the starting activity remained after heating at 74°C for 17 sec. Heating the enzyme at 55°C led to autolysis. The enzyme attacked casein, its fractions, bovine serum albumin and cytochrome c. It also attacked β -lactoglobulin.

Key Words: *Pseudomonas fluorescens*, Proteinase, Characterization

378 Application of a model system to evaluate the effect of pH on the texture of Cream cheese. M. Almena-Aliste* and P.S. Kindstedt, *University of Vermont, Burlington, VT/USA.*

A model system that uses ammonia to increase the pH of cheese was used to study the effect of pH on Cream cheese texture. Full-fat Cream cheese and one-third reduced-fat (Neufchatel) cheese were obtained from a retail source. Cheeses were sectioned into samples (10x40x65mm) and the samples were randomly assigned to three groups. Control samples were vacuum packaged and stored at 4°C for up to 5 d. Treatment samples were exposed to ammonia for either 5 or 10 min in a desiccator cabinet to increase the pH. Treated samples were then immediately vacuum packaged and stored at 4°C for up to 5 d. Triplicate samples of control and treatment cheeses were randomly chosen after 1, 2, 3, 4 and 5 d of storage and analyzed for pH and texture. Texture was evaluated objectively by rheological analyses using a Texture Analyzer machine (TA-XT2) fitted with a 12.5 mm cylinder probe, directly on sample cheese (6°C). The parameter *maximum force*, evaluated on the force-displacement curve during a penetrometric test (7 mm depth), was used as an index of the mechanical resistance of the cheese. The entire experiment was repeated once using different batches of cheese. A RCB split-plot ANOVA was used to evaluate the effects of exposure time to ammonia and storage time on pH and texture. The relationship between cheese pH and texture was evaluated by linear regression. Exposure to ammonia significantly increased the pH of both full-fat and reduced-fat cheeses, and significantly decreased the texture values of full fat cheese. Texture of reduced fat cheese was not significantly affected by exposure to ammonia. Strong negative correlations between the pH and texture of full fat cheeses were observed in both experimental trials ($r = -.89; -.94$). Correlations between the pH and texture of reduced fat cheeses were not as strong ($r = -.51; -.80$). Presumably, textural differences were caused by pH-induced changes in the interactions among water-fat-protein-stabilizer which define the structure of Cream cheese, but the nature of those interactions are not well understood.

Key Words: Cream cheese texture, Rheology, Cheese pH

379 Impact of CO₂ addition to milk on selected analytical testing methods. Y. Ma*, D. Barbano, J. Hotchkiss, and S. Murphy, *Northeast Dairy Food Research Center, Cornell University, Ithaca, NY.*

Addition of CO₂ to raw milk and dairy products can be used to control the growth of bacteria at refrigeration temperatures. The objective of this study was to determine the effects of dissolved CO₂ in milk on the performance of four routine testing methods: antibiotic residue test, freezing point test, infrared milk composition analysis, and alkaline phosphatase test. Raw or pasteurized whole milk was carbonated at < 4°C to contain 0 (control), 200, 400, 600, and 1,000 ppm added CO₂. Addition of CO₂ to raw milk (up to 1,000 ppm) had no effect on the performance of the three antibiotic (β -lactam) tests, namely, SNAP, Charm II Sequential Tablet, and Delvo-P. Carbonation of milk to 1,000 ppm decreased milk pH from 6.61 (control) to 6.15 (measured at 38°C). Milk freezing point decreased in a linear fashion with increasing concentrations of dissolved CO₂, from -0.543°C (control) to -0.595°C (1,000 ppm). The effect of CO₂ on milk pH and freezing point was reversible upon removal of dissolved CO₂ by vacuum. Increased CO₂ levels in

milk shifted the IR absorption spectrum at the lactose reference wavelength (7.651 to 7.788 μ m), which caused the corrected lactose readings to decrease and the corrected fat B readings to increase. Changes in fat A and protein readings, both uncorrected and corrected, were relatively small compared to those of fat B and lactose. For the alkaline phosphatase test, pasteurized milks with six levels of carbonation (0 to 1,000 ppm) were intentionally adulterated with 0, 0.05, 0.1, and 0.2% added raw milk. Addition of CO₂ did not influence the ability of Fluorophos, Charm, and Scharer Rapid tests to differentiate between a pasteurized milk and milk that had been contaminated with raw milk or was equivalently under-pasteurized.

Key Words: carbon dioxide, analytical testing methods

380 Development of colonic pre-cancerous lesions in rats fed synthetic and natural sources of conjugated linoleic acids and nordihydroguaiaretic acid. D. D. Gallaher*¹, C. M. Gallaher¹, H-J. Cho¹, A. Saari Csallany¹, and R.J. Baer², ¹*MN-SD Dairy Foods Research Center, University of Minnesota, St. Paul, MN,* ²*MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Conjugated linoleic acid (CLA) is a naturally occurring fatty acid produced by microbial fermentation in the rumen that is thought to have chemoprotective properties. We hypothesize that CLA acts by inhibiting 15-lipoxygenase activity. Two studies were conducted to determine the effect of synthetic CLA and a natural source of CLA, normal and high CLA containing butter, on the development of colonic precancerous lesions (aberrant crypts, AC) and bile acid excretion on carcinogen treated rats. In Study I weaning rats were fed a modified AIN93-G containing 20% corn oil (C), C + 0.1% CLA, C + 0.4% CLA, C + 0.8% CLA, C + 0.1% NDGA (nordihydroguaiaretic acid, a known 15-lipoxygenase inhibitor), or 20% butter fat (B) for 10 days. Rats were then administered dimethylhydrazine (15 mg/kg B.W.) once a week for two weeks by gavage, and continued on their diets for 8 weeks. Animals fed C + 0.8% CLA, C + 0.1% NDGA, and 20% B developed significantly fewer AC and AC foci compared to C. The 20% B had increased total bile acid excretion. In Study II the same protocol was used, but the diets fed were C, B, and 20% high CLA butter (HB). High CLA butter was produced by feeding Holstein cows a 50:50 ratio of forage to concentrate with 2% added fat from Menhaden fish oil. Butter contained 2.5 g CLA/100 g fat. In addition 20% B was fed post initiation. Feeding 20% B post initiation did not alter AC compared to C. However, 20% HB significantly decreased AC and AC foci. These results suggest CLA has chemoprotective properties in this colon cancer model and supports the hypothesis that CLA acts by inhibiting 15-lipoxygenase.

Key Words: Conjugated Linoleic Acid, Colon Cancer, Butter

381 Sensory characteristics of milks with different casein to serum protein ratios. D.M. Barbano*, M.A. Rudan, and Y. MA, *Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.*

Whole milk was separated into skim and cream. The skim was micro-filtered using a 0.1 μ m ceramic membrane to produce a 3 X casein concentrate and a permeate containing milk serum proteins. The protein portion of the MF permeate was concentrated about 15 X by ultrafiltration (UF). Combinations of MF retentate, cream, UF retentate from MF permeate, and lactose were used to make a matrix of 20 different pasteurized, homogenized milk samples. There were 4 fat levels (0.1, 1.0, 2.0, and 3.3%) and 5 target ratios of casein to serum proteins (approximately, 80/20, 65/35, 50/50, 35/65, and 20/80). The true protein (3.11%) and anhydrous lactose (4.70%) content was constant for all 20 samples. The calcium content decreased from about 1200 mg/kg at an 80/20 ratio to 600 mg/kg at a 20/80 ratio at all fat levels. The experiment was replicated 3 times with different batches of milk. Hunter color measurements, relative viscosity, and a quantitative descriptive analyses (14 panelists) were done. As casein to serum protein ratio decreased, L-value decreased at all fat levels, but the magnitude of the decrease was larger at lower fat levels. The impact of the decrease in casein to serum protein ratio from 80/20 to 20/80 on relative viscosity was larger than the impact of a decrease in fat from 3.3 to 0.1%. Relative viscosity at 4°C increased with increasing fat content and increasing casein to serum protein ratio. Change in fat content and casein to serum protein ratio influenced the scores for all appearance descriptors. The decrease in casein to serum protein ratio caused the appearance scores to decrease

greatly at low fat levels but not at high fat levels, cream aroma scores to decrease at high fat levels and not low fat levels, thickness scores to decrease at all fat levels. Mouth coating and drying scores decreased as casein to serum protein ratio decreased. The overall quality ratings for skim and 1% fat milks decreased as casein to serum protein ratio decreased, but overall quality rating was not influenced by casein to serum protein ratio at 2%. The overall quality rating of full fat milk was higher for lower casein to serum protein ratio than for high to lower the positive impact of lower mouth coating and lower mouth drying scores.

Key Words: Microfiltration, Fluid milk, Casein to serum protein ratio

382 Quality attributes of vanilla ice cream in the North Carolina market. A.P. Hansen* and M.D. Keziah, *North Carolina State University, Raleigh.*

Vanilla ice cream samples were obtained from local dairies and grocery stores. These samples were collected over a two-year period and analyzed for body, texture and flavor. A panel of 10-15 dairy judges were trained according to ADSA guidelines. The body and texture was evaluated first by placing a spoonful in the roof of the mouth and evaluating the coldness and degree of ice crystals present. The major body defects of the premium ice creams were slightly coarse, icy and gummy. Several samples had a perfect body and texture. The major flavor defects were cooked and too high flavor. Several samples had no flavor defect. The mid-range priced ice creams body and texture was coarse and icy, weak and gummy. Several samples had an excellent body. The major flavor defects were cooked, too high flavor, unnatural flavor, lacks flavor and syrup flavor. The lower priced ice creams exhibited many defects. The major body defects going to the least were coarse and icy, gummy, weak, crumbly and sandy. The flavor defects were cooked, lacks flavoring, whey, old ingredients, syrup flavor, unnatural flavor and oxidized. It was evident that all three classes of ice cream could be improved in quality. Several of the low cost ice cream samples were unsaleable from a flavor standpoint. This is where the greatest improvement needs to be made in evaluating raw ingredients before making the mixes.

Key Words: Vanilla ice cream, Sensory evaluation, Quality

383 Quality attributes of cottage cheese in the North Carolina marketplace. A.P. Hansen* and M.D. Keziah, *North Carolina State University, Raleigh.*

The per capita consumption of cottage cheese continues to decrease each year. This may be related to the quality of cottage cheese available to the consumer in the retail market. Cottage cheese samples were evaluated over a two-year period from N.C. dairies and grocery stores. The evaluation was conducted with at least 10-14 trained dairy judges. Attributes in appearance body/texture and flavor were evaluated according to ADSA protocol. Eight-six percent of the samples had slight to definite shattered curd. The other 14% had the following defects: free whey, free cream, matted and lacks cream in that order. The body and texture defects were gelatinous, pasty, weak and soft approximately 7% for each defect followed by firm and rubbery and overstabilized at 14% each. Approximately 29% were mealy and grainy and 15% of the samples had no defect. The major flavor defect was high acid and diacetyl. Other minor flavor defects that were observed are bitter, flat, lacking freshness, oxidized, rancid and whey. It is apparent from evaluating commercial cottage cheese samples that there is great room for improvements in flavor body and texture. If dairies would produce better quality cottage cheese, the per capita sales would increase.

Key Words: Cottage cheese, Sensory evaluation, Quality

384 Modification of pizza sauce to limit changes in composition and melted consistency of pizza cheese. R.H. Ouellette* and P.S. Kindstedt, *University of Vermont, Burlington.*

Previous studies demonstrated that Mozzarella cheese lost calcium, gained moisture, and changed in melted consistency during contact with pizza sauce. The objective of this research was to determine whether fortification of pizza sauce with calcium lactate, NaCl and a humectant (FRUITRIM[®]) would simultaneously limit the loss of calcium, uptake of moisture and undesirable changes in melted consistency. On three separate occasions, LMPS Mozzarella cheese was obtained from a commercial cheese plant on the day after manufacture and stored for 1 wk at 4°C. Then, test samples (1x1x3 cm) were prepared and randomly assigned to

sterile petri dishes containing no pizza sauce (control), pizza sauce, or pizza sauce fortified with 0.5% calcium, 0.3% NaCl and 5% humectant. Petri dishes containing cheese or cheese plus sauce in a 1:1 (w/w) ratio were vacuum packaged and stored at 4°C for up to 12 d. On day 1, 2, 4, 8 and 12 of cheese:sauce contact, cheese samples were analyzed for pH, moisture, salt and calcium contents and apparent viscosity. Data were analyzed according to a RCB split-plot ANOVA. Salt content and pH decreased significantly and similarly in cheese samples that were exposed to unfortified or fortified sauce. In contrast, cheese exposed to fortified sauce did not decrease in calcium content, whereas, cheese exposed to unfortified sauce decreased significantly. Cheese exposed to fortified or unfortified sauce increased significantly in moisture content. However, moisture uptake was reduced by ca. 55% in the fortified treatment. Exposure to unfortified sauce caused significant decreases in apparent viscosity, symptomatic of a loss of structure and function. In contrast, cheese exposed to fortified sauce showed only small decreases in apparent viscosity, indicating significantly less change in structure and function than that caused by the unfortified sauce. The data suggest that fortifying the pizza sauce to minimize the loss of calcium from, and uptake of moisture by, the cheese may enhance the stability of Mozzarella cheese in refrigerated pizza.

Key Words: Mozzarella cheese, Pizza, Functionality

385 Development and application of a model system to increase the pH of Mozzarella cheese. P.S. Kindstedt, A.B. Zielinski*, and M. Almena-Aliste, *University of Vermont, Burlington.*

It is generally accepted that the pH of Mozzarella cheese influences functional characteristics. However, it is very difficult to study the independent effect of pH because attempts to change the pH of cheese by changing manufacturing conditions often result in other changes, such as in mineral content or proteolytic activity, that confound the pH effect. Therefore, our objective was to develop a post-manufacture model system to study the independent effect of pH (while minimizing confounding effects) on the characteristics of LMPS Mozzarella cheese. The model system achieves incremental increase in the pH of cheese by exposing test samples to an ammonia atmosphere for varying lengths of time. Preliminary studies indicated that a large surface area to volume ratio, such as in shredded cheese, is needed to achieve uniform increase in pH throughout the cheese sample. In numerous experimental trials, the pH of commercially-manufactured shredded LMPS Mozzarella cheese increased in a linear manner ($r > .90$) with time of exposure to ammonia in the pH range of ca. 5.2 - 7.0, with an apparent buffering region at ca. pH 5.9 to 6.0. An exposure time of ca. 10 min was needed to increase the cheese pH by 1.0 pH unit. Cheese total solids percentage did not change significantly during exposure times of up to 18 min. The model system was employed in numerous experiments to study the relationship between cheese pH and apparent viscosity. Apparent viscosity increased in a linear manner ($r > .90$) with increasing cheese pH in the range of ca. 5.2 up to 6.5. Raising the cheese pH by exposure to ammonia resulted in a noticeably more fibrous and elastic melted consistency, which may have been caused by pH-induced shifts in calcium distribution. The model system was scaled-up so that larger batches of cheese (up to 2-kg) could be exposed to ammonia to achieve a controlled increase in pH. The scaled-up system may offer a useful approach to study the effect of pH on the physico-chemical, enzymatic, functional and structural characteristics of cheese.

Key Words: Mozzarella cheese, Functional characteristics, Cheese pH

386 Development and application of a model system to decrease the pH of Mozzarella cheese. P.S. Kindstedt*, A.B. Zielinski, C. Ge, and M. Almena-Aliste, *University of Vermont, Burlington.*

Previous studies demonstrated that it is possible to incrementally increase the pH of Mozzarella cheese by exposing the cheese to an ammonia atmosphere for varying lengths of time. The objective of this study was to use a similar approach to decrease the pH of Mozzarella cheese. The model system achieves incremental decrease in the pH of cheese by exposing the cheese for varying lengths of time to an atmosphere equilibrated with acetic acid. Preliminary studies indicated that much longer exposure times are needed to decrease the pH by exposure to volatile acetic acid than to increase the pH by exposure to ammonia. It was necessary to expose commercially obtained shredded LMPS Mozzarella cheese to the acetic acid atmosphere for 24 h at 4°C, in order to achieve

a 0.6 unit decrease in pH; e.g., a decrease from pH 5.3 to 4.7. Decreasing the cheese pH to ca. 4.7 by exposure to volatile acetic acid resulted in a perceptible increase in the whiteness of the cheese and a dramatic change in melting characteristics. Specifically, commercially obtained LMPS Mozzarella cheeses that had pH values reduced from ca. 5.3 to 5.4 to ca. 4.7 to 4.8 using this model system assumed a granular non-cohesive consistency with a complete loss of ability to flow and stretch when melted at 60°C. The results demonstrated that decreasing the pH of Mozzarella cheese has a dramatically different effect on melting characteristics than increasing the pH, which may be caused by pH-induced shifts in calcium distribution. A scaled-up version of the model system may offer a useful approach to study the effect of pH on the physico-chemical, enzymatic, structural and functional characteristics of cheese. In the present studies, the commercial test cheeses had already developed peak functionality at the time of pH adjustment. Future studies should focus on altering the cheese pH immediately after manufacture in order to evaluate the effect of pH on changes during aging.

Key Words: Mozzarella cheese, Functional characteristics, Cheese pH

387 Effect of frozen storage on functional properties of Mozzarella and non-pasta-filata style pizza cheeses. M.-I. Kuo* and S. Gunasekaran, *University of Wisconsin, Madison.*

Meltability, free oil formation, and stretchability were used to assess the effect of aging time, ripening before (2, 7, and 14 d at 4°C) or after (7 and 14 d at 4°C) freezing, and frozen storage (1 and 4 wk at 20°C) on properties of Mozzarella and non-pasta-filata style pizza cheeses. Cheeses were cut into 7×10×5-cm blocks and vacuum-sealed one day after manufacture. The results obtained were compared with unfrozen control samples, aged at 4°C between 7 to 21 d. A modified squeeze flow method was used to measure cheese meltability. The amount of free oil released from cheese upon heating was measured using a computer image processing system. The stretchability of the melted cheese was measured by a uniaxial horizontal extension test. The results indicate that frozen storage significantly affects the functional properties of Mozzarella cheese. However, the effect depends on the aging time before and after freezing. In contrast, frozen storage does not have a significant effect on the functional properties of non-pasta-filata style pizza cheese. The optimal freezing treatments for minimal loss of desirable functional properties were determined. The Mozzarella cheese should be aged one week at 4°C before freezing and storing it for 4 wk at 20°C. The cheese should be thawed and aged for one week at 4°C before consumption. The non-pasta-filata style pizza cheese can be stored up to 4 wk at -20°C followed by thawing and aging at 4°C for 9 to 16 d.

Key Words: Cheese, Freezing, Functional Properties

388 Comparison of melt profiles of LMPS Mozzarella manufactured by pasta filata and stirred curd methods. C.M. Chen, A.L. Dikkeboom, M.E. Johnson, and M.G. Zimbric*, *Wisconsin Center for Dairy Research, Madison.*

The melt properties of pasta filata (brined) and stirred curd LMPS Mozzarella cheese were compared at 10, 30, 60, and 90d of aging using the thermal melt tube test and the newly developed melt profile analysis. Cheeses had similar melt characteristics as measured by a thermal tube test. The thermal tube test assesses cheese meltability by measuring the distance a disc of cheese flows over time. Yet, the cheeses had different melt characteristics when baked on a pizza. After 10d, the pasta filata Mozzarella tended to flow off the crust, while the stirred-curd Mozzarella did not over-flow until it was at least 30d. A newly developed melt profile analysis simultaneously measures the changes in cheese height and temperature, providing information on softening time (s), softening temperature (°C), rate of flow (V/s), complete melt time (s), complete melt temperature (°C) and extent of flow (% decrease in cheese height at complete melt). The manufacturing methods did influence the softening temperature and complete melt temperature and the extent of cheese flow. The cheese softening temperatures for the pasta filata and stirred curd at 10 and 30d were 42.5, 40.5°C and 43.7, 41.2°C, respectively. There were similar trends for complete melt temperature. The extent of flow for pasta filata style was greater when compared to stirred curd at 10 and 30 d. This indicates that the stirred curd cheese requires a higher cheese temperature to begin flow, completely melt and to exhibit a greater extent of flow. Cheese composition (46.6 % moisture, 22.9% fat, 25.46% protein, and 1.57% salt), pH and degree of proteolysis did

not significantly differ. It is proposed that differences in the melt profiles are related to the microstructure of the cheese as influenced by the manufacturing technique.

Key Words: Mozzarella, Stirred Curd, Melt

389 Comparative study of *Lactobacillus acidophilus* strains for probiotic characteristics. S. Oh*¹, C. H. Chai², S. Kim², Y.-J. Kim¹, R. H. Liu¹, H. S. Kim³, and R. W. Worobo¹, ¹*Department of Food Science & Technology, Cornell University,* ²*Department of Animal Science, Korea University,* ³*Culture Systems Inc, Misawaka, IN.*

Lactobacillus acidophilus has been studied for use as a probiotic culture such as dairy products and dietary supplements. *Lb. acidophilus* is considered to have a higher tolerance to gastric juice and bile acid than other yogurt starter cultures. Some *Lb. acidophilus* strains can assimilate cholesterol during growth in the presence of bile under anaerobic condition. The objectives of this study were to compare the probiotic characteristics of twelve *Lb. acidophilus* strains for their ability of cholesterol assimilation, production of CLA (conjugated linoleic acid), and viability under artificial gastrointestinal fluids. Strains were variable with regard to production of CLA and acid tolerance. The ability of cholesterol assimilation had some variation among *Lb. acidophilus* strains, but strains could be classified into two groups of assimilation levels (P<0.05). The group of high cholesterol assimilation exhibited significantly higher resistance to 0.3 and 0.5% bile acid compared to the group of low cholesterol assimilation (P<0.05). However, acid tolerance was not related to the ability of cholesterol assimilation but the ability to assimilate cholesterol of *Lb. acidophilus* may be related to bile-resistant.

Key Words: *Lactobacillus acidophilus*, Probiotics, Cholesterol Assimilation

390 Purification and partial amino acid sequence of a acidocin 30SC, a bacteriocin produced by *Lactobacillus acidophilus* 30SC. S. Oh*¹, S. Kim², J. J. Churey¹, and R. W. Worobo¹, ¹*Department of Food Science & Technology, Cornell University,* ²*Department of Animal Science, Korea University.*

Acidocin 30SC, a bacteriocin produced by *Lactobacillus acidophilus* 30SC, was purified by ammonium sulfate precipitation, hydrophobic interaction chromatography (Octyl-Sepharose CL4B), and reverse-phase chromatography (Resource RPC). Active fractions from Octyl-Sepharose column chromatography were pooled and applied to FPLC on a reverse-phase column. The active fractions from the reverse-phase column were pooled and reinjected onto the FPLC column with a linear gradient of acetonitrile. Elution of Acidocin 30SC coincided with the absorbance peak at 34% acetonitrile. The molecular weight of Acidocin 30SC was estimated to be 3.5 kDa by tricine-SDS-PAGE. The sequence of 23 N-terminal amino acid residues from purified Acidocin 30SC was identified as follows: NH₂-Ile-Gln-Gln-Leu-Gly-Phe-Gly-Phe-Met-Leu-Gly-Glu-Ala-X-Gly-Ile-Gly-Pro-Glu-X-X-Phe. Acidocin 30SC did not contain any modified amino acids such as lanthionine or methyl-lanthionine. The N-terminal sequence of Acidocin 30SC was compared with the others of the NCBI database using the Blast program. No sequence similarity was found to any bacteriocins. Acidocin 30SC appears to be a new bacteriocin with activity against a range of bacteria that warrants further investigation.

Key Words: Acidocin 30SC, Bacteriocin, Purification

391 Fermentation of fructooligosaccharides by lactic acid and probiotic bacteria. H. Kaplan* and R. Hutkins, *University of Nebraska, Lincoln.*

Utilization of fructooligosaccharides (FOS) by lactic acid bacteria and bifidobacteria may play an important role in determining which organisms become established in the intestinal tract. Therefore, FOS fermentation may be an important criteria for selection of bacterial strains to be used as probiotics. The objectives of this research were to develop a cultural method for identifying bacteria that ferment FOS and to screen commercial dairy starter culture and probiotic strains for this property. Identification of FOS-fermenting strains was based on the development of acid in MRS agar to which glucose was replaced by 2% purified FOS. The purified FOS was comprised of three components - a

glucose monomer (G) linked α -1,2 to two or more β -2,1-linked fructosyl units (F), to give GF₂, GF₃, and GF₄. Of the 28 strains of lactic acid bacteria and bifidobacteria we examined, 12 of 16 lactobacilli and 7 of 8 bifidobacteria were able to ferment FOS. Included among the FOS-fermenting strains were several commercial probiotic strains, although the widely used strain *Lactobacillus* GG was a non-fermenter. None of the four streptococci fermented FOS. Growth studies were also done for bacteria grown in MRS broth containing glucose, FOS, or no added carbohydrate. Only strains that gave a positive FOS fermentation reaction by the agar method were able to reach high cell densities and to lower the pH to below 4.0 in the MRS broth containing FOS. Analysis of the fermentation broths by HPLC revealed that the FOS-fermenting strains consumed only GF₂ and GF₃, and none fermented GF₄. In contrast, growth experiments in which *Escherichia coli*, *Salmonella* and *Enterobacter* were inoculated into minimal broth cultures containing pure FOS revealed that these bacteria had limited capacity to utilize FOS as a carbon source. These results demonstrate that FOS utilization is a property unique to specific strains of probiotic bacteria.

Key Words: Fructooligosaccharide, Probiotic, Lactic Acid Bacteria

392 Acid tolerance of *Lactobacillus acidophilus* increases following exposure to supernatant from early stationary phase cells. R. Hage* and P. Courtney, *The Ohio State University, Columbus.*

Lactobacillus acidophilus must overcome the stresses imposed on it by the food system and the digestive tract of the host in order to function as a probiotic. *L. acidophilus* cells at stationary phase have demonstrated an increased resistance to stress compared to cells at earlier stages of growth. The objective of this study was to find evidence of extracellular signaling in response to stress, and to assess whether or not such signals are involved in acid stress resistance. Supernatants were collected from *L. acidophilus* NCFM cultures grown to mid-log and early stationary phases in MRS pH 6.5. These were adjusted to pH 7.0 with NaOH and filter-sterilized. Part of the early stationary phase supernatant was heated to 75°C for 5 minutes. Cells grown to mid-log phase in MRS pH 6.5 were then incubated in each of the three supernatants for two hours. They were then centrifuged, washed, suspended in MRS pH 1.6 and plated on MRS agar immediately and at 15 minute intervals for 60 minutes. After 45 minutes at pH 1.6, the mean log reduction for cells exposed to unheated early stationary phase supernatant was 3.10 compared to 5.49 for cells in mid-log phase supernatant and 4.43 for cells in heat-treated early stationary phase supernatant. After 60 minutes at pH 1.6, only cells incubated in unheated early stationary phase supernatant formed viable colonies on MRS agar. This indicates that early stationary phase cell supernatants contain a heat-sensitive factor(s) that appear to confer acid-stress resistance on mid-log phase cells.

Key Words: *Lactobacillus acidophilus*, Acid-tolerance, Stress

393 Translocation and clearing of *Lactobacillus acidophilus*. M. G. Conde, C.L.L.F. Ferreira*, I.D.P. Marlieri, E. Teshima, and L. M. Borba, *Universidade Federal de Vicosa.*

Probiotics are functional foods carrying large numbers of beneficial bacteria from the host's intestinal tract. The most commonly applied microorganisms as probiotics are those of the *Lactobacillus* and *Bifidobacterium* genera. *Lactobacillus acidophilus* NCFM is a strain isolated from humans, present in several probiotics. Despite its wide use, there is little information on its translocation to the host's organs. To investigate this process, 110 animals comprising two groups of 50 weaned Wistar rats (control and test), and one basal group (10 animals) were used. The control group received a standard diet (AIN-93, "ad libitum") and 0.1 ml skimmed milk/day. Besides the standard diet, the test group received 0.1 ml skimmed milk containing 1.0×10^{10} CFU/ml of a strain of *Lactobacillus acidophilus* of human origin for 14 days. After this time, 10 animals were killed and had their spleens, hearts, livers and kidneys screened for *Lactobacillus* (time 0). The same procedure was repeated at 7, 14, 21, and 28 days. The highest translocation was observed for the spleen. The average translocation for the other organs did not differ significantly from each other. However, the counting at 28 days after the end of the experiment indicated an elimination (% clearing) of the microorganisms translocated from the spleen (100), liver (100), heart (100), kidney (98.32). The evaluation of the organs from the control and basal groups did not indicate the presence of *Lactobacillus* in MRS agar. The numbers translocated cells, besides being

low, were constantly eliminated during the evaluation period. The time required for the complete elimination of *Lactobacillus* was calculated for the different organs according to the regression models adjusted and corresponded to 25.7; 27.5; 27.7; and 32.1 for the spleen, liver, heart and kidneys, in that order. The current data suggested that 32.1 days after the end of a 14 day period of probiotic consumption containing 1.0×10^{10} CFU/ml of *Lactobacillus acidophilus*, the organs here in studied were cleared from the translocated cells. Since the implications of microbial translocation in the host with different degrees of debility is not known, the translocation capacity is suggested to be an important parameter for the selection of strains to be used as probiotics.

Key Words: Probiotics, Translocation, *Lactobacillus acidophilus*

394 Impact of starter culture on whey flavor variability. R.M. Tomaino*, D.L. Larick, and L.G. Turner, *North Carolina State University, Raleigh.*

Although the knowledge pertaining to the functional and nutritional properties of whey has greatly increased, research focused on the development of the characteristic flavor of whey is lacking. The characteristic whey flavor has been considered a limiting factor in full utilization of whey ingredients in food products. Off flavor development in dried whey products has traditionally been attributed to a combination of Maillard browning and lipid oxidation reactions with little emphasis on the contribution of start culture activity. To study the effect of starter cultures on whey flavor, three commercially available single strain lactococcus lactis cultures were each used to produce Cheddar cheese whey, along with a control that utilized glucono- δ -lactone for acid development. Whey was drained, filtered, clarified, pasteurized (77°C/16s), bottled and frozen until analysis. Flavor characteristics were evaluated by descriptive sensory analysis using trained sensory panelists. Dynamic headspace analysis, coupled with gas chromatography-mass spectroscopy, was conducted, to quantitatively and qualitatively characterize volatile compounds. Assessment of proteolysis and lipolysis were performed using an o-phthalaldehyde spectrophotometric method and gas chromatography to identify free fatty acids, respectively. Greater volatile production ($p < 0.05$) occurred in the whey produced with cultures compared to the control, and differences could be detected between the whey samples and the control. The degree of proteolysis was greater ($p < 0.05$) among the whey produced with a culture compared to the control, with differences detected between the cultures. Results have indicated that the starter cultures contribute lipolytic enzymes, which is evident when comparing free fatty acid data between starter culture samples and the control. Sensory data substantiated the analytical differences. The ability of starter culture to impact the flavor profile of the resultant whey has been demonstrated. Further research should focus on elucidating the impact of starter cultures in the production of whey ingredients with the goal of inhibiting or limiting the production of the characteristic whey flavor.

Key Words: Whey, Off-flavor, Lactococcus lactis

395 Inhibition of *Lactococcus lactis* ssp. *lactis* c2 bacteriophage proliferation in *L. lactis* ssp. *lactis* C2 grown in medium containing heat treated *L. lactis* ssp. *lactis* c2 phage-peptide. C.L. Hicks*, *University of Kentucky, Lexington.*

Preparation of phage-peptide was problematic because of contamination by bacteriophage (phage). A modification was needed to prepare an uncontaminated phage-peptide. Peptides from c2 phage were heat treated and tested for phage inhibition activity. Peptides were prepared by hydrolyzing *Lactococcus lactis* ssp. *lactis* c2 phage (1×10^8 pfu/ml) with ficin (0.01%) for 6 h at 31°C. Hydrolyzed phage were micro-filtered (MiniKross, 0.2 μ m) to remove cellular debris. Filtrate was ultra-filtered through a YM3 (Millipore) UF membrane (3000 MW Cut-Off) at 5°C. Portions of the permeate (250 ml) were heat treated at 101, 111, or 121°C for 15 min. Heat treated permeates were cooled and freeze dried. Sterilized M17 media with CaCl₂ were prepared (8 tubes containing 25 ml medium) to which the three heat treated peptides were added (2.5% peptide w/w, added to 6 tubes) and inoculated with *L. lactis* ssp. *lactis* C2 (4%). At 1 h four tubes were infected with *L. lactis* ssp. *lactis* c2 phage (1×10^2 pfu/ml). Culture growth and lysis was monitored spectrophotometrically (λ_{600nm}). Culture grown in media containing the heat treated phage peptides were not inhibited by the peptide. When C2 culture in medium without peptide was infected with c2 phage lysis of the culture occurred after 270 min of incubation. Lysis of the C2

culture also occurred after 270 min of incubation when the media contained phage peptide heat treated at 101°C irrespective of whether it had been infected with c2 phage. These data indicated that bacteriophage survived the heat treatment and contaminated the freeze dried peptide. However, when C2 culture was grown in media containing the 111 and 121°C heat treated peptide and infected with c2 phage lysis did not occur. These heat treated phage-peptides may have effectively prevented the infective phage from attaching to C2/s antigenic binding sites better than the 101°C heat treated peptides.

Key Words: c2 Bacteriophage, *Lactococcus lactis*, Peptides

396 Characterisation of *Bifidobacterium* isolates using amplification of the transketolase/transaldolase intergenic spacer region in combination with temporal temperature gel electrophoresis. J. P. Burton* and G. W. Tannock, *University of Otago, Dunedin, New Zealand.*

Comparisons of the V regions of 16S rRNA sequences has proved to be an essential tool in the classification of bacteria. These 16S rRNA sequences are relatively conserved in the case of some bacteria, such as in the case of *Bifidobacterium* species isolated from human faeces. We have detected an intergenic region within the *Bifidobacterium* chromosome that may prove useful in at least characterising, and perhaps identifying, isolates of these bacteria. The region varies in size between isolates, but is approximately 100-200 bp in length and is located between the transketolase (*tal*) and transaldolase (*tal*) genes. To test the degree of sequence variability of this region in different bifidobacterial species, we compared the migration of PCR amplicons of the region by temporal temperature gel electrophoresis (TTGE). Nine *Bifidobacterium* type cultures of species detected in human faeces were characterised by this method. The DNA fragments generated from *Bifidobacterium angulatum* and *B. catenulatum* had the same migration properties in the gel, as did those of *B. infantis* and *B. longum*. However, *B. adolescentis*, *B. breve*, *B. bifidum*, *B. dentium* and *B. pseudocatenulatum* could be differentiated according to the thermal stability of their respective amplicons.

Key Words: *Bifidobacterium*, TTGE

397 Study of exopolysaccharide production by *Lactobacillus rhamnosus* ATCC 9595M in a supplemented whey permeate medium. M. Macedo*¹, C. Lacroix¹, and C-P. Champagne², ¹Dairy Research Centre STELA, Quebec, Canada, ²Food Research and Development Centre, St-Hyacinthe, Canada.

The aim of this work was to study exopolysaccharide (EPS) production during pH controlled batch fermentations of *Lactobacillus rhamnosus* ATCC 9595M in a whey permeate (WP) medium supplemented with Yeast Nitrogen Base (YNB). A central composite design consisting of 20 fermentations, 14 unique combinations (8 factorial points, 6 axial points) and 6 replications (central points) and response surface methodology were used. This experimental design allows to study in interaction the effect of three factors: incubation temperature (22-42°C), WP concentration (1.6-8.4%) and YNB supplementation (0-2.0%). Fermentation were conducted in two 4 L fermentors, with agitation set at 100 rpm and pH controlled at 6.0 by addition of NH₄OH 3N. Optical density (625nm), cell counts (CFU/mL), lactic acid production (g/L), lactose consumption (g/L), apparent viscosity of the broth medium (Pa.s) and EPS production expressed as total sugar (mg/L) were measured. Biomass response surface analysis showed not significant difference for the main factors and only the WP*T interaction was significant (p<0.05). The YNB factor exhibited a limited effect on maximum biomass and EPS production, indicating that YNB may not be suitable as nitrogen source, for the culture. Data showed that EPS production was not growth-associated. Maximal EPS production varied from 40 to 257 mg/L. The EPS productivity calculated for maximum EPS production varied from 0.75 to 6.0 mg EPS/L.h. The EPS quality was measured by the apparent viscosity of the broth at 200 s⁻¹. Apparent viscosity decreased for long incubation times in the range of optimal growth temperature, without a parallel decrease in EPS concentration, which may indicate a possible hydrolysis of EPS. The EPS production by *Lb. rhamnosus* ATCC 9595M in this study, even with a limited nitrogen source, is close to maxima reported in the literature for lactobacilli and optimal culture medium.

Key Words: exopolysaccharide, whey permeate, lactobacilli

398 Capsule formation by nonropy yogurt cultures affects its viscoelastic properties. A. Hassan*, M. Corredig, and J. Frank, *The University of Georgia, Athens.*

Little information is available on the development of gel structure resulting from acidification of milk by starter cultures. Furthermore, no previous studies have focused on the effect of nonropy capsule-forming cultures on the viscoelastic properties of yogurt gels. This work was designed to study the structure formation of yogurt made with cultures containing ropy *Lactobacillus delbrueckii* ssp. *bulgaricus* (R), capsule-forming nonropy *Streptococcus thermophilus* (CNR) and noncapsule-forming nonropy (NCNR) cultures. Reconstituted (11% w/v), steamed (95°C for 15 min) skim milk was inoculated with 5% of R, CNR or NCNR and yogurt was prepared at 37°C. Inoculated milk was transferred to a controlled stress rheometer (Rheometric Sci. Piscataway, NJ) and samples were oscillated at a frequency of 0.1 Hz at 1% strain. The pH was monitored simultaneously as the rheometer readings were recorded, by measuring the pH in a parallel control cup held at the same temperature in a water bath. Fermentation was terminated at pH 4.5. The gelation behavior was plotted against pH. Gelation point which was defined at G' > 1 Pa occurred at pH 5.3 in milk fermented with R and NCNR cultures. On the other hand, milk fermented with CNR cultures showed structure development at higher pH values (5.5). This was in agreement with our previous observation using confocal scanning laser microscopy. Milk containing CNR showed higher complex shear moduli (G*) than that containing R or NCNR. The loss tangent of all gels increased to a maximum shortly after gelation. When G* was normalized against the value of its own G* at the final pH (4.5) and plotted vs. pH, the gelation profiles of milk fermented by different strains fell into a single master curve. In conclusion, the minimal deformation applied in our experiment showed that the gelation profile of milk fermented by ropy or nonropy lactic cultures was similar. The presence of bacterial capsules affected the casein aggregation behavior, which was different from that of milk fermented by R or NCNR. °

Key Words: Bacterial capsules, Yogurt, Viscoelastic properties

399 Characterization and differentiation of *Lactobacillus acidophilus* strains for use as probiotics. S. McKechnie¹, N.P. Shah*¹, and M.L. Britz², ¹Victoria University of Technology Melbourne, Australia, ²University of Melbourne, Victoria, Australia.

There is increasing evidence that *Lactobacillus acidophilus* plays a health-promoting role by contributing to the maintenance of the intestinal flora. However, despite their use in probiotic products, the relative therapeutic value of various strains has yet to be determined. In addition, the onset of molecular techniques has led to the re-classification of presumed *L. acidophilus* species. Therefore it is important to confirm the identity of candidate strains. The aim of this study was to assess a variety of techniques for the characterisation and differentiation of a group of probiotic strains. A culture collection previously identified as *L. acidophilus* based on phenotypic criteria were screened to select strains with functional properties typical of probiotic bacteria. Among the selection criteria were the ability of strains to withstand low pH and high bile concentrations which are commonly encountered in the gastrointestinal tract. Those strains that met initial selection criteria were further characterised by traditional biochemical techniques and molecular methodologies including SDS-PAGE of whole cell proteins and Pulsed-Field Gel Electrophoresis of chromosomal DNA digested with the restriction enzyme *Sma*I. Those strains that differed considerably to the reference strain were further characterised using 16S rRNA sequence analysis. Whilst 16S rRNA sequence analysis confirmed the identity of isolates as members of the *L. acidophilus* species, the use of a polyphasic taxonomy approach, encompassing biochemical and physiological characteristics with that of molecular based phenotypic tests broadened the classification of *Lactobacillus* species and provided valuable information relating to the therapeutic value of these strains.

Key Words: *L. acidophilus*, Pulsed Field Gel Electrophoresis, 16S rRNA

400 Pediocin production by recombinant *Streptococcus thermophilus*. G.A. Somkuti*, P.E. Coderre, and D.H. Steinberg, Eastern Regional Research Center, ARS-USDA.

Pediocin production by *Streptococcus thermophilus* ST128 was induced by transformation with recombinant plasmids carrying the pediocin gene cluster (*ped*) from *Pediococcus acidilactici*. The amount of pediocin produced (U/ml) was measured by an agar spot-test with *Listeria innocua* as the test organism. Level of pediocin production was influenced by the length and temperature of incubation and the type of medium used. Pediocin production by ST128(*ped*) was at a maximum (up to 12,800 U/ml) in tryptone-yeast extract-lactose medium after 8 h of incubation at 40°C and remained unchanged during the next 16 h. Several other full strength or diluted media (Elliker's, MRS, skim milk, cheese whey) were also suitable for pediocin production by ST128(*ped*). At and above 45°C, pediocin titers dropped and bacteriocin was undetectable at a growth temperature of 50°C. Level of pediocin production remained essentially unchanged in skim milk diluted 1:10 (v/v, 25,600 U/ml), and in cheese whey diluted 1:5 (v/v, 12,800 U/ml). In the course of 10-12 daily transfers of recombinant ST128 cultures, the amount of pediocin produced was reduced. The gradual loss in bacteriocin activity was caused by structural and segregational instability of the transforming plasmid vector with the *ped* gene cluster in the new host. It is concluded that pediocin production is possible in relatively inexpensive whey-based media. Findings also suggest that recombinant lactic acid starter cultures with stably maintained *ped* may have direct application in controlling the growth of deleterious bacteria (*Listeria*) in dairy foods.

Key Words: Pediocin, *Streptococcus thermophilus*

401 Identification and characterization of PepO2 from *Lactobacillus helveticus* CNRZ32, an enzyme involved in the hydrolysis of a β -casein derived bitter peptide. Y.S. Chen*¹, J.E. Christensen², and J.L. Steele, ¹Department of Food Science, ²Department of Bacteriology.

Analysis of the peptides formed by cell free extracts of *Lactobacillus helveticus* CNRZ32 with the bitter peptide β -casein fragment 193-209 (β -CN(f193-209)) indicated that an endopeptidase and/or carboxypeptidase was involved in its hydrolysis. Peptides derived from a carboxyl blocked β -CN(f193-209) suggested that the enzyme involved was an endopeptidase. To identify this enzyme a gene bank of *Lb. helveticus* CNRZ32 constructed in *Escherichia coli* DH5 α was screened for activity with β -CN(f203-209) which was N-terminally blocked and had a C-terminal ρ -nitroanilide group. A total of 188 pools of clones (10 clones each) was screened and 2 isolates with activity were identified. DNA sequencing of the isolate revealed an open reading frame which could encode a peptide with 56% identity and 72% similarity to PepO of *Lb. helveticus* CNRZ32. Therefore this gene was designated *pepO2*. The open reading frame contained 1947 bp, encoding for a peptide containing 649 amino acid residues, with a putative Shine-Dalgarno sequence and a putative transcriptional terminator sequence. Northern hybridization was performed and the results suggested that *pepO2* is monocistronic. To examine the physiological role of PepO2 and its role in the hydrolysis of β -CN(f193-209), a PepO2⁻ derivative of CNRZ32 will be constructed.

Key Words: bitterness, peptidases, *Lactobacillus helveticus*

402 Amplification of the core streptavidin and β -galactosidase genes and construction of a core *Stp-LAC 4* fusion gene. L.M. Damasceno¹, F.L.M. Passos*¹, V.G. Janolino², and H.E. Swaisgood², ¹Universidade Federal de Vicosa, Vicosa-UFV, MG, Brazil, ²North Carolina State University, Raleigh.

Advances in biotechnology have increased the potential use of enzymes to modify or develop food processes or functionalities of food ingredients. There are many advantages in using immobilized enzyme bioreactors, including the capability of continuous and automated processing. Nevertheless, bioreactor preparation and regeneration are major economic factors limiting commercial use. Therefore, isolation, purification and immobilization of an enzyme in a single step is an ideal strategy. This can be accomplished by adding an affinity tail to the enzyme of interest. The enzyme β -galactosidase, which has application in the dairy industry, was used as a model to demonstrate this approach to bioreactor preparation. The core streptavidin gene (core *Stp*), from *Streptomyces avidinii*, and the β -galactosidase gene (*LAC 4*), from *Kluveromyces*

lactis, were amplified and modified by PCR to facilitate cloning into a *Pichia pastoris* expression and secretion vector. The *LAC 4* gene was cloned in-frame to the core *Stp* gene in a two-step procedure. *P. pastoris*, the methylotrophic yeast, was transformed by electroporation with the resulting plasmid and recombinant cell lysates and culture media were passed through biotinylated glass beads to prepare the immobilized enzyme bioreactor.

Key Words: Fusion protein, Streptavidin-beta-galactosidase fusion, Enzyme bioreactor

403 Occurrence of *Bacillus sporothermodurans* and the influence of the thermal processing procedure on its presence in Brazilian UHT milk. P.B. Zacarchenco*¹, M. F. F. Leitao¹, M. T. Destro², and C. Andrighetto², ¹Faculdade Engenharia de Alimentos-UNICAMP, Campinas, Sao Paulo/Brazil, ²Faculdade Ciencias Farmaceuticas-USP, Sao Paulo, Sao Paulo/Brazil.

Bacillus sporothermodurans(BSP) has been isolated worldwide, but mainly in European countries as a usual contaminant of UHT milk. Even being nonpathogenic, generally its presence results in product rejection based on international microbiological standards limiting the counts to a maximum of 100 cfu/ml. In this research work, the occurrence of BSP was evaluated in UHT milk samples produced in different regions of Brazil (Central, South and Southeast) and processed by the indirect thermal treatment system (plate or tube exchangers) or by the direct system (steam infusion or steam injection). A total of 100 commercial samples were analysed both quantitatively by spread plate technique using Brain Heart Infusion Esculin Agar (BHI-E agar) and qualitatively after thermal shock treatment (115°C/7min), followed by incubation and plating in that medium. The results showed a total of 45 per cent of the examined samples with counts above 100 cfu/ml, varying from 2 .10⁴ and 9.5 .10⁵ cfu/ml (20,000 and 950,000 cfu/ml). However, 71.4 per cent of the samples processed by indirect system were above limits, while none of the samples heat treated by the direct system, that allows a more drastic temperature condition, were rejected. A similar picture was observed in the qualitative evaluation, with contamination levels of 71.7 and 22.2 per cent for the indirect and direct system, respectively. A total of 300 cultures were isolated from contaminated samples, showing cultural, morphological and biochemical patterns similar to BSP, except a late glucose fermentation capacity showed by most of the isolated strains. When 24 representative strains were submitted to PCR-RAPD evaluation and compared to the reference BSP strain (DSMZ 10599), they were confirmed as *Bacillus sporothermodurans* based on their DNA pattern.

Key Words: Uht milk, *Bacillus sporothermodurans*, Heating system

404 Optimizing of beta-cyclodextrin recycling process for cholesterol removal in cream. H. S. Kwak*, H. M. Suh, J. Ahn, and H. J. Kwon, *Sejong University, Seoul, Korea.*

This study was designed to find optimum conditions of β -cyclodextrin recycling process by applying four different factors (ratio of solvent to cholesterol- β -cyclodextrin complex, mixing speed, mixing temperature, and mixing time) in cholesterol dissociation from cream. Using the ratio of 6 to 1 (solvent to the complex) showed the highest cholesterol dissociation rate (82.50%) when mixed at 1000 rpm at 50°C for 1 h. Mixing speed did not significantly affect the cholesterol dissociation. Also, mixing time appeared to be insignificant. The optimum mixing temperature was 50°C, and mixing at 40°C resulted in a significantly lower rate, compared with that at 50°C. In a subsequent experiment, using recycled β -cyclodextrin only showed 75.07% of cholesterol removal in cream, while 6 to 4 mixture of recycled to unused β -cyclodextrin increased cholesterol removal to 95.59%, which is highly close to that of 100% unused β -cyclodextrin.

Key Words: Beta-cyclodextrin recycling, Cholesterol removal, Cream

405 Binding bile salts by soluble fiber: potential use in dairy products containing a probiotic culture. E.P. Cuesta* and S.E. Gilliland, *Oklahoma State University, Stillwater.*

Soluble fibers are used in the food industry as stabilizers and thickeners. It has been widely reported that soluble dietary fibers can be hypocholesterolemic. One of the mechanisms for cholesterol reduction

relates their ability to bind bile salts, enhancing steroid excretion from the body.

Binding of sodium taurocholate, sodium glycocholate and sodium cholate by soluble fibers (guar gum, xanthan gum and soluble fiber extracted from oat meal) was measured.

The fiber solutions were incubated in presence of the individual bile salt for 2 and 4 hours at 37 °C, then the fiber was precipitated and the bile salt remaining in the solution was analyzed by HPLC to determine the percentage of binding.

None of the fibers exhibited the ability to bind sodium glycocholate at the concentration tested but all of them were able to bind sodium taurocholate and sodium cholate with different range of percentage depending of the concentration of bile salts.

The major conjugated bile salt in the human intestine is sodium glycocholate and at least part of it can be deconjugated by selected probiotic cultures. Thus, the combined use of a selected probiotic culture that deconjugates sodium glycocholate with a selected soluble fiber that will bind the free sodium cholate could be useful in improving the control of serum cholesterol levels.

Key Words: Soluble Fiber, Bile Salts

406 Cholesterol recovery from beta-cyclodextrin complex of cream using a new combined method with immobilized cyclomaltodextrinase of alkalophilic *Bacillus* sp. KJ133 and solvent extraction. H. J. Kwon, H. J. Jung, and H. S. Kwak*, *Sejong University, Seoul, Korea.*

A new combined method with enzymatic hydrolysis of β -cyclodextrin (β -CD) and solvent extraction of cholesterol from the hydrolyzed mixture was developed to recover the cholesterol of β -CD-cholesterol complex that was prepared from dairy products such as cream, milk, and cheese. Alkalophilic *Bacillus* sp. KJ133 was isolated from soil as a cyclomaltodextrinase (cyclomaltodextrin dextrin hydrolase, EC 3.2.1.54, CDase) producer. The intracellular CDase was prepared from cells by sonication and showed the optimum β -CD hydrolyzing activity at pH 6.0 and 50°C. The CDase efficiently hydrolyzed the β -CD of β -CD-cholesterol complex and free cholesterol was easily extracted from the hydrolyzed mixture using non-polar solvent such as ethyl acetate. To increase the stability of a free CDase, we also developed an immobilized CDase using sodium alginate as a carrier. Immobilized CDase showed a high yield of cholesterol recovery in a time dependent manner than that of free one. Gas chromatography analysis showed that over than 70% of cholesterol was recovered from the β -CD-cholesterol complex of cream while only 3 and 29% of cholesterol were recovered from solvent extraction and free CDase treatment, respectively. The cholesterol recovered can be used as raw material for steroid synthesis and this method will provide an efficient way to recover the cholesterol or other organic compound from the β -CD-cholesterol or -organic compound complex.

Key Words: Cholesterol recovery, Cyclomaltodextrinase, Beta-cyclodextrin

407 Increase in conjugated linoleic acid (CLA) in fermented milk by *Lactococcus lactis*. Y.-J. Kim^{*1}, S.T. Lee¹, and R.H. Liu¹, ¹*Dept. of Food Science, Cornell University, Ithaca, NY.*

Conjugated linoleic acid (CLA) is a strong anticarcinogenic agent and dairy products are good sources of CLA. Increase in CLA concentration will improve the value of dairy products. The objective of this work was to elevate CLA concentration in fermented milk (e.g. yogurt). Fifteen strains of dairy starter culture were screened for CLA production using sunflower oil (containing 70% linoleic acid) as a substrate in culture medium. Among the screened strains, *Lactococcus lactis* IO1 showed the highest CLA producing ability. Sunflower oil in culture medium inhibited bacterial cell growth and the optimal concentration of sunflower oil for CLA production was 0.2 g/L which accounted for 0.5% of total fat in milk. Moreover, additions of dry powder and glucose in the culture also increased CLA concentration, and the CLA production was directly proportional to the bacterial cell number. The elevated bacterial cell number reduced the time to lower the pH in culture medium, but low pH inhibited isomerase reaction and enhanced biohydrogenation, which led to the decrease in CLA accumulation. The addition of potassium phosphate buffer enhanced CLA production by increasing buffer capacity and keeping culture medium for a longer period of time. Using this technique, CLA production could be increased up to 2.3 times higher than control fermented milk ($p < 0.01$). In conclusion, our results have

demonstrated that CLA formation in fermented milk could be elevated. The maximum CLA formation in fermented milk was affected by various factors such as a bacterial strain, cell number, optimal substrate concentration and period of incubation time at neutral pH.

Key Words: Conjugated linoleic acid, *Lactococcus lactis*, Sunflower oil

408 Factors affecting the filtration of nonfat milk through diatomaceous earth to reduce *Bacillus* endospore contamination. A. Bienvenue^{*1} and R. Jimenez-Flores¹, ¹*DPTC, Cal Poly State University, San Luis Obispo, CA.*

Endospore forming bacteria are naturally occurring in milk as a result of contamination from the environment and the equipment. In addition, endospores are a concern in food products because of their exceptional heat resistance during processing. Therefore, endospore forming bacteria can affect both the quality and the safety of foods. Previous studies on bio-silicate performance in endospore removal resulted in the selection of Hyflo Super-Cel[®]. The objective of this study was to determine the variables within milk that affect endospore removal efficiency during filtration. Eight milk samples (defatted early lactation raw, defatted late lactation raw, defatted bulk tank raw, and five commercial pasteurized nonfat milk) were enriched in *Bacillus* endospores to a concentration of 1×10^5 CFU/ml. Simultaneously, a filtration cake was built by recirculation of a bio-silicate slurry according to a set pattern (i.e. flux and time). The spiked milk was then filtered through the diatomaceous earth filtering cake. Samples of milk before and after filtration were characterized for their microbial load, protein, fat, ash, citrate, calcium, and chloride content. Moreover, SDS-PAGE was used to compare the proteins adsorbed to the diatomaceous earth. Results showed that milk filtered through a Hyflo Super-Cel[®] cake removed greater than 90% of the aerobic mesophilic endospore population added in raw late lactation and in early lactation defatted milk. In addition, the temperature history of the raw milk samples and the centrifugation process used to remove the fat affected the endospore removal efficiency. High endospore removal was associated with the presence of a 55 kDa protein adsorbed to the bio-silicate. None of the remaining milk constituents studied could be correlated to the endospore removal efficiency obtained.

Key Words: Bio-silicates, Endospore removal, Milk

409 Water-soluble nitrogen accumulation and *Lactococcus* cell viability after high pressure processing of Cheddar cheese. U. Nienaber, T.H. Shellhammer, W.J. Harper, and P.D. Courtney*, *Ohio State University, Columbus.*

High pressure processing is a novel manufacturing technology capable of activating and/or inactivating many food enzymes and causing bacterial cell leakage and death. Application of high pressure to Cheddar cheese for short periods of time early in the ripening process has the potential to shorten ripening time. Applying higher pressures later during ripening may allow cheese manufacturers to arrest ripening at a desired level. The objective of this study was to determine the effects of high pressure treatments on cheese ripening, as inferred by water soluble nitrogen content.

Cheddar cheese was manufactured on site with a commercial mesophilic starter culture, divided into one pound blocks (6x6x14cm), and vacuum packed in high barrier flexible pouches. Duplicate samples of two-week old cheese were pressure treated using an ABB Quintus Food Processor QFP-6 Cold Isostatic Press. Applied pressures ranged from 100 to 800 MPa for one or five minutes at 25°C. *Lactococcus* cell viability was determined immediately after pressure treatment of cheeses by plating serial dilutions on M17-lactose medium. Cheeses were stored at 4°C throughout the study, and sampled periodically. WSN was extracted using standard methods and measured by the Kjeldahl method.

Lactococcus cell viability was only slightly decreased from the non pressure-treated control (8.0×10^8 cfu/g) at pressures of 100 to 300 MPa for one minute. One-minute treatments at 400 and 500 MPa caused 3.4 and 4.6 log cycle reductions respectively. Less than 10^3 cfu/g was detected after 600-800 MPa treatments. One month after pressure treatment, WSN content was determined in control and pressure-treated cheeses. These analyses revealed the highest WSN level in the 400 MPa-treated cheese and the lowest level in the 700 MPa-treated cheese. In addition, a five-minute treatment of two week old cheese at 800 MPa dramatically arrested the evolution of water soluble nitrogen over time when compared to the control cheese. High pressure treatment impacts

the extent of water soluble nitrogen accumulation over time in Cheddar cheese, and thus may have potential for use in controlling cheese ripening.

Key Words: High Pressure, Cheese, Ripening

410 Influence of cream homogenization and protein supplementation of Cheddar cheese milk by ultrafiltration on functionality of whey protein concentrates. M. G. Nair, V. V. Mistry*, and B. S. Oommen, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Cheddar cheese was made from milks that were supplemented with (C1) or without (C0) ultrafiltered skim milk of 16.2 to 16.9% protein and standardized to 0.7 casein-to-fat ratio with unhomogenized (P0) or homogenized (P1) cream (35% fat). The four treatments were P0C0 and P1C0 (3.2% protein) and P0C1 and P1C1 (6.0% protein). Whey pasteurized at 62.8°C for 30 min was ultrafiltered at 55°C to 9:1 for C0 and 5:1 for C1, separated, standardized to 0.4% fat, and spray dried. The protein contents of whey protein concentrates (WPC) of C1 (51.8%, P0C1 and 51.2%, P1C1) were higher ($P < 0.05$) than those of C0 (50.2%, P0C0 and 47.7%, P1C0). Moisture of WPC was approximately 4% and fat ranged from 2.9 to 3.2%. Foaming capacity of 10% protein solution expressed as overrun increased ($P < 0.05$) from 399 (C0) to 582% (C1), but decreased ($P < 0.05$) from 639 to 415% as the pH increased from 4.5 to 10.0. Foam stability, measured as percentage of intact foam after 5 min, increased ($P < 0.05$) as pH of the solution was raised from 4.5 (16.1%) to 10.0 (61.8%). Emulsification activity index measured as the amount of light absorbed at 500 nm by a 3:1 emulsion of 2% protein solution at pH 7 and corn oil homogenized with a Polytron homogenizer at 19,000 rpm for 3 min decreased ($P < 0.05$) from 0.525 (P0) to 0.411 (P1) and from 0.635 (C0) to 0.302 (C1). Stability of the emulsion was reduced ($P < 0.05$) from 9.57 (P0) to 6.51% (P1). The fracturability (load at yield point) of heat induced gel (10% protein solution (pH 7) heated at 80°C for 30 min) increased ($P < 0.05$) from 12.81 (P0) to 14.14 Newton (P1) and decreased ($P < 0.05$) from 14.36 (C0) to 12.59 Newton (C1). Gel firmness (load at 80% compression) increased ($P < 0.05$) from 19.54 (C0) to 22.24 Newton (C1). Cheese milk process modifications such as use of homogenized cream and ultrafiltered milk have potential to influence functionality of WPC.

Key Words: Whey protein concentrate functionality, ultrafiltration, cream homogenization

411 Influence of rennet source on casein peptide formation in low-fat Mozzarella cheese. E.L. Malin*, M.H. Tunick, and P.W. Smith, *Eastern Regional Research Center, U.S. Department of Agriculture, Wyndmoor, PA.*

Rennets from four different sources were used to prepare very low fat Mozzarella cheese to determine the specific proteolytic attributes of each rennet. The four rennets, widely used in commercial production of Mozzarella cheese in the U.S., included calf stomach rennet, fermentation produced chymosin, and fungal aspartic proteinases from *Cryphonectria parasitica* and *Rhizomucor miehei*. SDS-PAGE of cheese extracts showed that the greatest loss in intensity of the alpha-s1 casein band after 6 weeks of storage at 4°C occurred in cheese made with calf rennet, whereas *C. parasitica* was more active on beta casein. An intense band at the gamma-1 position in the *C. parasitica* extract may represent a different beta casein fragment created by the action of *C. parasitica* aspartic proteinase. HPLC of the four cheese extracts at 6 weeks showed many major peptides with similar or identical retention; some peaks occurred in clusters. More peptides were produced by *R. miehei* and calf rennet than by fermentation produced chymosin and *C. parasitica*. Although x-ray crystal structures suggest that the four rennet enzymes have almost identical active sites, very small sequence differences in other portions of each enzyme may induce slight alterations in binding site and/or turnover rate that result in the proteolytic variations observed by SDS-PAGE and HPLC.

Key Words: Mozzarella, Rennet, Peptide

412 Cheese yield and standardization of milk for cheese making: comparison of predictive cheese yield equations. C.M. Chen, A.L. Dikkeboom*, M.E. Johnson, and M.G. Zimbric, *Wisconsin Center for Dairy Research, Madison.*

The physical characteristics of cheese are influenced to a great extent by cheese composition. Standardization is the process of changing milk composition to produce a cheese of desired composition. Accurate standardization requires a formula that not only predicts cheese yield but also fat in the dry matter (FDM) of the cheese. All yield equations incorporate cheese moisture, milk composition (casein and fat) and use factors to express the recovery of casein and fat in milk in cheese. The main difference between predictive cheese yield formulas is how they measure the contribution of non-fat, non-casein solids (other solids) to cheese yield. One type of yield formula (Emmons, general formula Type H, *J. Dairy Sci.* 76:914-920) bases the contribution of other solids to cheese yield on non-fat, non-casein solids of whey, salt in the cheese, moisture of the cheese and a solids exclusion factor (sef). The Van Slyke formula uses fat and casein recovery and cheese composition to calculate the contribution of other solids to cheese yield. If the casein recovery is held constant at .96, the Van Slyke puts a premium on the conversion of milk fat to cheese to determine the contribution of other solids to cheese yield. We analyzed the data from 92 vats of reduced-fat Cheddar cheese. The milk casein to fat ratio was standardized by cream removal or the addition of reconstituted NDM. Percentage of total milk solids was varied from 9.53 to 14.31. Yield was calculated using the Van Slyke and Emmons equations, and data from all the vats of cheese. An average Van Slyke equation was determined and compared to the Emmons Type H equation using either a sef factor of 0 or .5. Average milk composition and fat recovery were used in both equations. Using a sef of 0, the estimation of yield by the Emmons equation was equivalent to the actual average cheese yield. Using a sef of .5 underestimated cheese yield. The average Van Slyke equation also precisely predicted cheese yield. The Emmons yield equation (sef=0), gave a more accurate prediction of cheese yield when fat recovery values were varied and incorporated into both yield equations.

Key Words: cheese yield, reduced fat

413 Characteristics of reduced fat Edam cheese with adjunct cultures. W. Tungjaroenchai*, M. A. Drake, and C. H. White, *Mississippi State University, Mississippi State.*

The influence of four adjunct cultures [*Brevibacterium linens* (BL2), *Lactococcus lactis subsp. diacetylactis*, *Lactobacillus helveticus* (LH212), and *Lactobacillus reuteri* (ATCC23272)] on chemical and sensory characteristics of reduced fat Edam cheese was studied. Mean fat and moisture contents of reduced fat cheese were 20.85 ± 0.76 and 42.95 ± 0.43, respectively. Fat and moisture of full fat control cheese were 30.06 ± 0.78 and 39.11 ± 0.60. Titratable acidity increased in all cheese with aging while pH initially decreased but increased in cheese after 5 mo. aging at 7°C ($p < 0.05$). Lactic bacteria counts were on average one log higher for reduced fat cheeses than for full fat control cheese with counts decreasing with aging. Free amino acids (FAA) in cheeses increased with aging. FAA was higher in reduced fat cheeses than in the full fat control cheese. Reduced fat cheeses containing *L. helveticus* exhibited the highest FAA ($p < 0.05$) content. The relative aminopeptidase activity of *L. helveticus* and *L. lactis subsp. diacetylactis* was higher than that of *L. reuteri* and *B. linens*.

Descriptive sensory panelists (n=9) did not detect differences among cheese treatments after 3 and 6 mo. ripening but age-developed flavors (fruity, nutty, brothy, free fatty acid) increased between 3 and 6 mo. ($p < 0.05$). Also, sweetness increased in cheese with aging. Expert panelists (n=6) detected differences in textural quality among the cheeses ($p < 0.05$). Textural quality of reduced fat cheeses increased with aging. Reduced fat control cheeses and reduced fat cheeses with *L. helveticus* and *L. reuteri* received the highest textural quality scores. The reduced fat control cheeses and reduced fat cheeses with *L. helveticus* and *L. lactis subsp. diacetylactis* received the highest flavor quality scores from the expert panelists. The addition of *L. helveticus* or *L. lactis subsp. diacetylactis* adjunct cultures to reduced fat Edam cheeses increased proteolysis and textural quality.

Key Words: Adjunct cultures, Proteolysis

414 Effect of fat composition and milk treatment on development of cheese texture. M. Almena-Aliste* and Y. Noel, *National Agronomic Research Institute, INRA, Dairy Technology and Analysis Research Unit, Jura, France.*

Effects of fat composition and milk treatment (raw/pasteurized) on changes in textural properties during ripening were evaluated on a semi-hard model cheese. Fat composition was changed by using milk fat produced by cows fed either with pasture or hay. The experimental cheeses were made in a pilot plant following the technological scheme of a pressed uncooked type cheese and then ripened at 13°C for 5 weeks. An experimental design with 4 randomized complete blocks and a 2² factorial treatment structure was used. Texture was evaluated by rheological analyses on cheeses, at 1-day and then each week, by using a Texture Analyzer fitted with a cylindrical probe of 10-mm diameter. The test combines penetrometry (to a depth of 10 mm) and relaxation (over 3 min). The following rheological parameters were calculated from the force-time curve: *slope, force and work to the maximum penetration depth, residual modulus, relaxation time and the constant terms K1 and K2.* Texture of 5-wk-old cheese was also evaluated by sensory analyses. Gross composition, calcium and chloride content were measured on 1-day and 5-wk-old cheeses. The pH was measured directly into 1-day old cheese. The repeated measurement data from cheeses were analyzed by using an ante-dependence model. Fat composition strongly modified the rheological properties of the 1-day-old cheeses. Cheeses manufactured with milk fat from cows fed with pasture showed more elasticity and less mechanical resistance. Effects of cream type on cheese texture could be explained by differences between fatty composition induced by cow feeding. Effect of milk treatment was significant on parameters associated with the mechanical resistance and the viscous component of cheese, at the latest stages of ripening. The pasteurized cheeses were firmer and less viscous. Effects of fat composition and milk treatment on cheese texture were less significant at intermediate ages of ripening (1-3 weeks). An interaction between the 2 factors was identified with the force to the maximum penetration depth on 1-day and 5wk-old cheeses.

Key Words: Cheese Texture, Pasteurization, Fat composition

415 Texture evaluation of cheese with soft consistency: effect of testing conditions on penetrometric parameters. M. Almena-Aliste*^{1,2}, Y. Noel¹, and A. Cepeda Suez², ¹INRA, *Dairy Technology and Analysis Research Unit, Poligny (France)*, ²Hygiene and Inspection of Foods, *Faculty of Veterinary-University of Santiago de Compostela, Spain.*

Rheological tests are used to evaluate objectively the textural properties of cheeses. Testing conditions have a critical role for this evaluation. The uniaxial compression test is currently being standardized within the IDF, while penetrometry has been less studied. The study aimed to select the testing conditions for penetrometry on cheese with soft consistency, considering both tool shape and penetration depth. Three penetrometric tool shapes were tested (ball, round or flat-end cylinders) at 3 different penetration depths (5, 7 and 10 mm). A mold ripened soft cheese was used as an experimental model. Cheeses were selected at 6 different ages from 0 to 5 ripening weeks in order to obtain a variability of textural properties. Rheological measurements were carried out with a Texture Analyzer at a constant displacement rate of 0.8 mm.s⁻¹, directly on whole cheeses at the ripening temperature (17°C). The different measurements were randomly distributed on the cheese at each age. Three variables were calculated from the force-displacement curve: the slope of the initial linear part, the maximum force and the work to maximum force (area under the curve until the maximum penetration depth). Data were analyzed by Analysis of Variance and Principal Component Analysis. Results showed that tool shapes influenced significantly penetrometric parameters. Both tool shape and penetration depth had lower effects at the beginning and the end of ripening time. The round-end cylinder tool was suitable for studying the change of mechanical properties of cheese during ripening but penetration depth should be adapted to cheese height. More the ball was the most appropriate tool shape allowing quasi non-destructive control on young and mature cheeses.

Key Words: Texture of Soft Cheese, Penetrometry, Testing conditions

416 Effect of late blowing inhibitors on bacteriological and chemical changes in Swiss cheese. S. M. El-Gindy*, *Assiut University, Egypt.*

In Swiss cheese made from milk infected with 100 spores of *Clostridium tyrobutyricum* and containing 0.02% potassium nitrate the bacterial content was markedly lower than that of cheese made from milk containing 2% of a nisin producing *Str. lactis* and that of the control cheese, after 6 weeks. Microorganisms present in all cheeses belonging to streptococci, lactobacilli, and micrococci. Streptococci were detected until the end of 6 weeks, micrococci predominated after 24 weeks. Addition of nisin-producing *Str. lactis* resulted in a higher pH value, reduced the decomposition of protein, did not improve cheese consistency and retarded flavor development. Potassium nitrated caused no appreciable change in the acidity of cheese, and improved the consistency. Both the nisin-producing *Str. lactis* and potassium nitrate prevented late blowing cheese. However, the latter may be preferred as the former was not beneficial to acid development and ripening of cheese.

417 Modification of buttermilk functionality with biosilicates. B.G. Fryksdale* and B. Jimenez-Flores, *California Polytechnic State University, San Luis Obispo, CA.*

Previous research has shown that biosilicates (BS) can be used to modify the functionality of dairy cream. This research was to determine if buttermilk (BM), can also be modified by this process. Four types of BS were evaluated; Calcium silicate (Ca), magnesium silicate (Mg), Hyflo (Hy), and R648. Treatment consisted of addition of BS to BM (0.5% w/w), agitation at 160F for 5 min., followed by removal of the BS by filtration. Treated BM was then used to prepare emulsions of 10% and 40% fat by homogenization at 1500/500psi, 155F. A spectrum of analysis was conducted, which included, small and large deformation rheological characterization, foaming and foam stability, particle size analysis, emulsion stability, and SDS-PAGE. Rheological characterization revealed G' of the control to be 1025 Pa. Treatment with Ca and Mg increased G' to 1350 Pa and 1200 Pa, respectively, while treatment with R648 and Hy had no effect. Steady stress sweeps of the 10% fat emulsions were used to compare complex viscosity. Viscosity of control was 0.0018 Pa.s while the Ca and Mg samples had higher viscosities of 0.003 Pa.s and 0.005 Pa.s, respectively. Differences in foaming characteristics of the 10% fat emulsions were also found. Samples treated with Ca and R648 showed greater foaming over others (a= 0.05). Additionally, the Ca sample produced a lasting stable foam, while others collapsed within 15 minutes. Emulsion stability evaluated by creaming rate monitored by a dynamic light scattering instrument showed decreased emulsion stability for all treated BMs. Particle Size Analysis showed that the Control and Ca 10% fat emulsions had a mean particle size of 1.68 while the Hy, Mg, and R648, all showed increased particle sizes of 1.78, 2.03, and 1.82, respectively. SDS PAGE showed that the BS that induced that greatest changes in functionality also had adsorbed a larger amount of certain proteins, particularly the high MW proteins commonly associated with the MFGM. In conclusion, certain BS, particularly Ca and Mg have tremendous potential to alter the functionality of the buttermilk. Ultimately, this novel process can be as a tool to help develop traditional or low fat dairy products with improved or unique texture, using exclusively dairy ingredients.

Key Words: Buttermilk, Biosilicates, Functionality

418 Effect of glycomacropeptide and high pressure homogenization on the stability of milk protein emulsions. S Bhatia* and R.L. Richter, *Texas A&M University, College Station.*

The objective of the study was to determine the effect of the presence of the glycomacropeptide in whey protein concentrate on the stability of emulsions prepared from milk proteins. Emulsions were made in solutions that contained 3% protein from a source of whey protein concentrate that contained the glycomacropeptide and a whey protein concentrate that did not contain the glycomacropeptide. Sunflower oil was added at 3 and 7% and the solution homogenized at 30 and 90MPa. The particle size distribution, creaming rate, and the viscosity of the emulsions was measured. The creaming rate was faster for samples homogenized at 30 MPa than for samples homogenized at 90MPa and results after homogenization at 30MPa were inconsistent. The mean particle size of particles in samples homogenized at 90 MPa was 0.322 and 0.3427 μ m. For samples with and without the glycomacropeptide, respectively. These values were 50% smaller than the size of particles

after homogenization at 90 MPa. The particle size in samples prepared from whey which contained the glycomacropeptide was smaller than the particle size in the emulsions prepared from whey which did not contain the glycomacropeptide when the samples were homogenized at 90MPa. There was no difference in the particle size of samples homogenized at 30MPa. Emulsions prepared from whey protein concentrate that did not contain the glycomacropeptide had the greatest viscosity after homogenization at both homogenization pressures. The viscosity of these emulsions was greater after homogenization at 30MPa than after homogenization at 90MPa. However, these emulsions were unstable and the results were variable. These results show that emulsions of this composition are more stable if they prepared by homogenization at 90 rather than 30MPa.

Key Words: Glycomacropeptide, High Pressure Homogenisation, Milk Protein Emulsions

419 Influence of pasteurization time/temperature and homogenization/pasteurization sequence on emulsion characteristics and influence of storage time. C. Bolling*¹, S. E. Duncan¹, T. Keenan¹, W. N. Eigel¹, K. Waterman¹, and K. Kaylegian², ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Wisconsin Center for Dairy Research, Madison.

Emulsification of modified butteroil in a dairy system would be beneficial for incorporating butteroil in food systems. A low melt fractionated butteroil has a more desirable nutritional profile. Emulsification of this butteroil with milk derived components would yield a 20% reformulated cream which is more desirable to the health conscious consumer. The objective is to determine the effect of HTST (71.7°C for 15 sec.) and UHT (148°C for 2 sec.) pasteurization and 2 stage homogenization (13.6 / 3.4 Mpa) before and after heat processing on emulsion stability and physical properties of reformulated creams throughout a 13 day storage period. Viscosity, creaming stability, feathering, and sensory quality of reformulated 20% cream formulated with fractionated low-melt butteroil (BO) in different milk-derived components were analyzed over a 13 day storage period at 7°C. Raw milk was separated at 55°C into skim milk (SM) and cream. Buttermilk (BM) was obtained from churning cream. Aqueous phase (AP) was obtained from a butter processor. The milk component formulations used for emulsification of the butteroil were 20% BO + 80% SM, 20% BO + 70% BM + 10% AP, and 20% milk fat cream. Creams which underwent UHT heat treatment displayed higher viscosity than creams heat treated at HTST. The 70%BM/10%AP/20%BO formulations which underwent UHT pasteurization were unstable. In addition, the 80%SM/20%BO formulation that underwent homogenization followed by UHT pasteurization was unstable. All creams demonstrated a decrease in creaming stability over a 13 day storage period. Regardless of formulation, storage period, homogenization sequence, and heat treatment, all formulations feathered from pH 4.70 to 5.00. All creams met standard quality expectations based on responses of 10 experienced panelists.

Key Words: Reformulated cream, Pasteurization, Viscosity

420 Rheological properties of microfibrillar cellulose and its interaction with milk components. J.M. Angold* and R. Jimenez-Flores, Cal Poly State University, DPTC, San Luis Obispo, CA.

Microfibrillar cellulose (MFC) is a stable biopolymer that is produced by the aerobic fermentation of *Acetobacter xylinum* and consists of a small fibrous diameter (0.1mm) as well as a large surface area. Prima-Cel, a product made primarily of MFC has been used as a thickening and stabilizing agent in salad dressings and sauces. The commercialized application of PrimaCel in dairy products has not been developed, however, preliminary research shows great potential for PrimaCel to be used to create low fat and fat free dairy products. The focus of this project was to understand how PrimaCel interacts with milk and its components at a macromolecular level. PrimaCel was tested in caseinates and whey protein isolates to determine if interactions were occurring between the proteins present in milk. PrimaCel (0.8%) was homogenized with water, skim, and both 3 and 5 percent of either potassium caseinate, sodium caseinate, calcium sodium caseinate, or whey protein isolate. Analysis was done using small deformation dynamic oscillatory rheology with increasing frequency from 1-100 radians/sec. The PrimaCel was found to have dilatant properties when mixed with caseins or whey proteins with

a larger storage modulus (G') than loss modulus (G''). It was also determined that as the percentage of casein or whey protein was increased from 3-5% there was a decrease in G' . Overall the PrimaCel homogenized in whey protein concentrate formed a gel with G' approximately 2.5 times larger than PrimaCel in casein. PrimaCel (0.8%) homogenized in 3% whey protein isolate gave a G' range of 42-50Pa, whereas in casein the G' ranged from 11-19Pa. It was also determined that with a higher pressure of homogenization PrimaCel forms a stronger gel in all of the components tested. Differential Scanning Calorimetry was used to correlate these results with enthalpy changes in cellulose and protein interactions.

Key Words: rheology, milk proteins, microfibrillar cellulose

421 Effect of inulin on some rheological and physical properties of acid milk gels with inulin. G. Perez-Hernandez* and R.L. Richter, Texas A&M University, College Station.

The objective of this study was to evaluate the effect of inulin on some rheological and physical properties of acid milk gels. NFDM was reconstituted to 12% MSNF with 0 and 2% fat and 0, 2, 5 and 10% inulin. The milk was heated at 90°C for 10 min and homogenized (20MPa). Glucono- δ -lactone (2% w/v) was added and the milk stored for six hours at 20°C. Then samples were stored overnight at 7°C and the rheological properties of stirred gels were then measured using a Brookfield rotational viscometer. Static and Dynamic yield stress were measured using the vane method. Syneresis was measured by centrifugation and the slope of the linear regression was determined as a coefficient of syneresis. The gel structure was observed by confocal scanning laser microscopy. Samples inoculated with yogurt culture were used for pH and acidity experiments. A Herschel-Bulkley model described the upward shear-rate flow behavior of the samples, while the downward shear rate curves were nearly linear. The hysteresis loop was used as a thixotropy coefficient. Increased fat and inulin concentration increased static and dynamic yield stress. With the increase in inulin and fat content, K and σ_0 value increased whereas n decreased affecting the Herschel-Bulkley models in the upward shear rate curve. The thixotropy coefficient increased as fat and inulin concentration was increased. Syneresis coefficient decreased with fat and inulin concentration. No differences were seen in the structure of the gels. Kinetics of pH and acidity were not affected by the concentration of fat and inulin. Inulin can be incorporated into yogurt to increase the gel strength and decreased syneresis and it will not affect the protein matrix.

Key Words: Inulin, Acid Milk Gels, Rheological Properties

422 Rheological and physical characterization of derivitized whey protein solutions. H.M. Hudson*, C.R. Daubert, and E.A. Foegeding, North Carolina State University, Raleigh.

Dairy ingredients mimicking the thickening functionality of gelatin, hydrocolloids, and starches have been a focus of current research. Pre-gelatinized starch is often employed in food applications because of the instantaneous nature of thickening and stability imparted by modification. Proteins have traditionally been excluded as an instantaneous viscosifying agent due to the requisite thermal treatments to create structure. Whey protein isolate (WPI) gels were prepared while manipulating heating time, pH, and mineral type/content, producing a variety of gel types/networks. Gels were subsequently frozen, freeze-dried, and ground into a powder. Once reconstituted in deionized water, gel powders were evaluated based on solubility, electrophoresis, and rotational viscometry. The protein powder exhibiting the largest apparent viscosity, highest degree of hydrolysis, and greatest solubility was selected for further analysis. Rotational viscometry was performed on solutions prepared from the selected derivitized powder at pH values between 3 and 8, temperatures of 5-90 C, and shear rates between 1-100 s⁻¹. Small amplitude oscillatory rheology was conducted at a constant stress of 1.0 Pa; frequency was ramped from 0.1 to 20.0 Hz, while temperatures were alternated between 25 and 90 C. Rheological analyses reveal a processing technique able to derivitize WPI into a product capable of forming cold-set weak gel structures suitable for thickening over a wide range of temperature and pH food systems. This cold-set feature may impart a wide range of potential applications such as malted-milk beverages, protein drinks, and nutritious liquid formulations for athletes, infants or the elderly.

Key Words: Whey Protein Isolate, Acid Hydrolysis, Cold-Set Gels

423 Tryptic hydrolysis of β -lactoglobulin A, B, and C. H. C. Nilsson², M. A. Paulsson², C. J. Coker¹, J. P. Hill¹, and L. K. Creamer^{*1}, ¹New Zealand Dairy Research Institute, Palmerston North, New Zealand, ²Univesity of Lund, Lund, Sweden.

The A variant of β -lactoglobulin (BLG) is hydrolyzed more rapidly than the B variant by several different proteolytic enzymes. The rate of loss of BLG A, B, and C with trypsin hydrolysis was studied as a function of pH, temperature, BLG concentration, added urea, and added palmitate using RP-HPLC (reversed-phase high-performance liquid chromatography) and SDS-PAGE (sodium dodecyl sulfate polyacrylamide gel electrophoresis). Peptide identity was confirmed by mass spectrometry. The major finding is that a number of the trypsin-sensitive peptide bonds are broken more rapidly in BLG A than in BLG B or C but that many others are cleaved at the same rate for all variants. Higher temperatures, addition of urea, and higher pH all increased the rates of reaction but palmitate decreased the reaction rate markedly. All of these treatments (except increased protein concentration) decreased the rate of BLG A hydrolysis relative to BLG B, but did not change the relative rates of BLG B and BLG C hydrolysis. It is not obvious whether BLG A is inherently less stable than BLG B or BLG C, as the thermal unfolding and the urea-induced equilibrium unfolding of BLG A is intermediate between that of BLG B and that of BLG C.

Key Words: Tryptic hydrolysis, Genetic variants

424 Binding of small amphipathic molecules to β -lactoglobulin. L. K. Creamer^{*1}, M. Blair¹, R. Korte², and G. B. Jameson², ¹New Zealand Dairy Research Institute, Palmerston North, New Zealand, ²Massey University, Palmerston North, New Zealand.

There has been much speculation about the role of bovine β -lactoglobulin (BLG) as a carrier of vitamins and fatty acids. We have innovated the technique of induced-circular dichroism (CD) to measure the association of reporter molecules with bovine BLG. One interesting example is 2:5-dinitrobenzoic acid covalently bonded to BLG. This probe is not chiral itself, but when it is bound to a chiral site it shows strong CD bands. Similarly retinol shows weak CD bands in the absence of BLG but strong signals in the presence of BLG at pH 8.0. This signal is weakened by addition of palmitic acid to the mixture showing partial displacement of retinol by the fatty acid. This indicates that the major site for retinol binding is the hydrophobic cavity that has been identified crystallographically as the binding site of fatty acids. BLG binds retinol strongly above pH 7.5, whereas it binds parinaric acids strongly above pH 5. These and other results indicate that the Tanford transition affects retinol binding but not parinaric acid binding, which is, however, affected by the protonation of the parinaric acid carboxyl group. Comparable experiments with retinoic acid suggest that its binding mode to BLG changes over the pH range 3-10, probably as a consequence of movement within the hydrophobic cavity. Experiments with retinyl acetate and retinyl palmitate suggest that the palmitate end of retinyl palmitate is in the cavity but the acetate end of retinyl acetate is in the solvent.

Key Words: β -Lactoglobulin binding site, Retinol binding, Retinyl palmitate binding

425 Effects of genetic variants on the rates of interaction of β -lactoglobulin and κ -casein. Y. H. Cho², H. Singh², and L. K. Creamer^{*1}, ¹New Zealand Dairy Research Institute, Palmerston North, New Zealand, ²Massey University, Palmerston North, New Zealand.

The heat-induced interaction of whey proteins, especially β -lactoglobulin (BLG), with κ -casein (KCN) is fundamental to all heat treatments that affect the functionality of milk products. As a starting point we have examined the effect of KCN on the established reaction pathway of heat-induced BLG unfolding and aggregation. KCN was purified directly from milk by centrifugation and size-exclusion chromatographic procedures to give a native polymeric product. KCN was added to either native BLG or to previously heated BLG and the mixtures heated. The rate of loss of BLG and the distributions of intermediate products were determined using polyacrylamide gel electrophoresis (PAGE). It was found that KCN reacted more rapidly with BLG that had been unfolded by prior heat treatment than with native BLG. Some monomeric KCN was also present in the reaction mixtures, no doubt as a result of disulfide bond interchanges between KCN and BLG. In all

cases KCN B was more reactive than KCN A and the BLG B was more reactive than BLG A or BLG C.

Key Words: κ -Casein, β -Lactoglobulin, Heat-induced interaction

426 The enzyme activities and milk performance in German Holsteins. L. Panicke^{*1}, M. Schmidt², J. Citek³, G. Erhardt⁴, V. Rehout³, and R. Staufenbiel⁵, ¹Research Institute for the Biology of Farm Animals, 18196 Dummerstorf, Germany, ²PH Kielce, Poland, ³Southbohemian University Ceske Budejovice, Dep. of Animal Breeding, Czech Republic, ⁴University Giessen, Institut of Animal Breeding and Genetics, Germany, ⁵Free University Berlin, Institute of Veterinary Physiology, Germany.

A high milk performance connected with a stabile health regarding metabolism and a sufficient fertility is been influenced from a well balanced distribution of energy. The anabolic and catabolic balance between protein synthesis and proteolysis in relation to lipogenesis and lipolysis are influenced by degradative enzymes. Aminopeptidases Arginyl- (ARG E.C.3.4.11.6.), Alanyl- (ALA E.C.3.4.11.14.) and Leucyl- (LEU E.C.3.4.11.1.) were analysed in the serum of 357 German-Holstein cows using Ala- and Arg-Naphtyl-derivate substrate. The sum of the animal effects of their enzyme activity SAAL = ARG + ALA + LEU increases not linear with the milk performance in the lactation in three different years. Genetic variants of growth hormone gene (GHG) and the milk protein genes (α_{S1-} , α_{S2-} , β -, κ -Casein and β -lactoglobulin) were determined in contemporary cows. The SAAL activity increased with the milk performance in different GHG genotypes. Under inclusion of β -casein-variants (β -CN) the enzyme activities for SAAL of β -CN A2A2 genotypes decreases to 8486 nMol/l/h under similar performances between β -CN A1A1 and β -CN A2A2, which is almost a half of a standard unit (S-% nearly 10 %). Cows with β -CN A2A2 genotype are associated with higher performance and around -2.5 days better intermediate gestation (serviceperiode) at the actual estimation on other animals with + 208 kg milk and + 11.5 fat+protein-kg (Panicke et.al.1998). Conclusions: A high milk performance could be combined with a high fertility on a genetic basis. Lower enzyme activities together with high milk performance presume, that the protein synthesis is increasing with a reduced proteolysis rate. Lower physiological load contributes to the better fertility. Genetic determined physiological values should not be maximized or minimized, but optimized. This optimization should be quantified.

Group	Genotype		Number	Fat+Protein	SAAL
	GHG***	β -Casein	n	kg	nMol/l/h
405	all	all	30	513	6637
406	all	all	141	506	8213
407	all	all	186	593	8780
407	VV*	all	9*	563	8394
407	VL	all	44*	584	8536
407	LL	all	133*	597	8888
407	LL	A2A2	23**	617	8486
407	LL	A1A1	23**	613	9020
407	LL	A1A2	48**	582	8897

Performance and enzyme activities of different genotypes

* total =186 cows

** the remaining to 133 are other genotypes

*** This part of the research was supported by CEZ J06/98/122200004

Key Words: cattle, milk, enzyme

427 Heat coagulation of camel milk. A. Metwalli, F. Ibrahim*, and K. Hassanein, *Minia University, Minia, Egypt.*

Heat coagulation time pH curve (HCT/pH) of camel milk in the range of (6.4-7.2) was measured at 120 C. The effect of urea, formaldehyde and mixture of them on heat coagulation time was studied. The results showed that, camel milk is not heat stable. However, the heat stability significantly increased at all pH studied (6.4-7.2) with dialysis of milk against Jennes & Koops buffer. Addition of urea alone in concentration of 10-30mM has no effect on HCT of camel milk. Moreover, addition of formaldehyde till 5mM has almost no effect. While increasing the concentration to 7.5 mM, the HCT greatly increased. It seems that there is a critical concentration of formaldehyde that affects the HCT of camel milk. A mixture of formaldehyde and urea (5mM of each) has a

slight effect on HCT. However, increasing the concentration of urea up to 10mM markedly increased the HCT. It could be concluded that heat coagulation behavior of camel milk is completely different from that of cow milk.

Key Words: camel milk, heat stability, urea

428 Reduced fat cheese production by fat removal from aged Cheddar cheese. B. K. Nelson*, C. C. Nicklas, and D. M. Barbano, *Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.*

Normally, reduced fat Cheddar cheese is made by removal of fat from milk prior to cheese making. Typical aged flavor does not develop when reduced fat Cheddar cheese is produced by this approach. Previous researchers have demonstrated that aged Cheddar cheese flavor intensity resides in the water-soluble fraction. Therefore, we investigated the feasibility of fat removal after the aging of Cheddar cheese. We hypothesized the typical aged cheese flavor would remain with the cheese following fat removal. Shredding, grinding, and blending were evaluated as methods of cheese preparation. Finely shredded cheese yielded the best fat release and may be the most practical. Efficiency of fat removal at various temperatures, times, and forces was determined. Shredded cheese samples were tempered at specific temperatures between 20°C and 41°C. Centrifugal force was varied from about 2,000 to 23,500×g for times from 5 to 20 minutes. Temperature had the greatest effect ($p < 0.05$) on the removal of fat, although force and time were also significant ($p < 0.05$). Time and force were less important at higher temperatures. A positive linear relationship between temperature and fat removal was observed from 20 to 33°C. At temperatures above 33°C both fat and water were removed. Fat reduction of 30 to 50% was easily achieved at temperatures $\leq 30^\circ\text{C}$ and the highest fat reduction achieved was 72%. A 50% fat reduction was attained at 30°C by either 23,500×g for 5 minutes or 6300×g for 10 minutes. A traditional cheese press was used to form the reduced fat cheese into blocks. The fat removed had some aroma but little or no taste. Reduced and full fat cheeses were analyzed for percent fat, protein, moisture, salt, and pH. The full fat aged Cheddar had a composition of 34.0, 25.0, 36.6, 1.74 and 5.15, respectively. The same cheese with approximately 50% fat reduction had a composition of 16.0, 32.0, 45.6, 2.21 and 5.13, respectively. Work is continuing to accumulate sensory data in addition to developing a continuous fat removal process.

Key Words: Cheddar, Composition, Reduced fat

429 Impact of low concentration factor (CF) micro-filtration (MF) on fat, protein, and calcium recovery in Cheddar cheese and cheese yield. M. Neocleous*, D.M. Barbano, and M.A. Rudan, *Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.*

Raw skim milk was microfiltered twofold (2X) using a 0.1 μm ceramic membrane at 50°C. The average true protein content of the retentate and permeate across the four days of cheese making was 5.31 and 0.53%, respectively. Cream and MF permeate were added back to the 2X skim retentate to achieve a constant casein to fat ratio of 0.68. A vat of cheese was made from each of 1X (control), 1.3, 1.6 and 2X CF cheese milks on four different days using a 4 x 4 randomized block design. Four different batches of raw milk were used. The mean fat content (3.33, 4.21, 5.05, and 6.11%, respectively), casein (2.28, 2.88, 3.45, and 4.15%, respectively), serum protein (0.52, 0.55, 0.56, and 0.59%, respectively), and calcium (0.11, 0.13, 0.15, and 0.17%, respectively) of the standardized microfiltered skim milk increased with increasing concentration factor. Mass balance accounting was done for fat, protein, and calcium in milk, whey, salt whey and cheese. Fat recovery was not influenced by CF. The protein recovery in the cheese increased significantly with increasing CF (72.4, 76.1, 78.9 and 81.4%, respectively), while protein recovery in the whey decreased (27.3, 23.4, 20.5, 17.9%, respectively) with increasing concentration factor. Cheese calcium recovery in the cheese also increased significantly (63.6, 70.6, 74, 78.4%) and whey recovery decreased (33.3, 27.4, 23.2, 19.7%) with increasing CF. These effects were expected because part of the protein and part of the calcium found originally in the milk are removed from the milk by MF prior to cheese making. Theoretical cheese yields were calculated using the Van Slyke formula and the Barbano formula. No significant changes were found in cheese yield efficiency with increasing concentration factor, but there was an increase in actual, composition adjusted,

and theoretical cheese yield (9.1, 11.6, 13.9, 16.8 kg per 100kg of milk, respectively) with increasing concentration factor.

Key Words: Microfiltration, Cheddar cheese, Yield

430 Automatic data acquisition and analysis of cheese melt profile. D. Venkatesan¹, C. H. Hwang¹, and S. Gunasekaran*¹, ¹*University of Wisconsin, Madison.*

We have developed a device called the "UW Melt Profiler" to monitor the cheese melt profile (i.e. cheese height vs. time curve) during heating of disk-shaped cheese samples in an oven. This melt profile contains information that may signify several cheese melt/flow events during heating. Currently, the cheese melt profile is analyzed using computer spreadsheet programs. This approach is not only tedious but is also very inconsistent. Therefore, our objective was to develop an automatic data acquisition and analysis procedure and software. The LabView (National Instrument, Inc.) was used as the basis for our software development. The software developed, named "CheeseMelt" is designed to interface with user via on-screen prompts. Upon execution, CheeseMelt automatically acquires cheese height and temperature data continuously as a function of heating time. A graphic interface displays the melt profile in real time. The program terminates data collection when the preset end point is reached and simultaneously processes the melt profile data. An output containing a number of useful cheese melt profile parameters such as: cheese softening point, end point, rapid flow time, maximum flow rate, average flow rate, total flow time etc. is generated. The performance of this automatic procedure was successfully verified with different cheese types, experimental protocols, and data analysis procedures. These parameters are relative measures of cheese properties, which can be used as product development and/or quality control tools. Therefore, our automatic analysis method is expected to simplify the cheese melt/flow evaluation procedure.

Key Words: Cheese, Melt profile, Software

431 Rheological characteristics of Monterey Jack hard goat cheese. R. Attaie*¹ and R. L. Richter², ¹*Prairie View A&M University, Prairie View,* ²*Texas A&M University, College Station.*

Pasteurized milk from French Alpine goats was processed to Monterey Jack hard goat cheese. Commercial mesophilic starter culture was activated twice and added to milk at the rate of 2% (v/v). After addition of rennet, cutting of the coagulum started 60 min later. Acidity of curd ranged from 0.21 to 0.23% and pH ranged from 5.60 to 5.70, when salting started at the rate of 2.5% (salt/curd). Starter culture was grown in tryptic soy broth in bulk quantities and cells were harvested by centrifugation at 6500 x g for 10 min at 4°C. The harvested cells were washed with distilled water and disrupted with a sonicator for a total of 10 min. The cellular extract was mixed with curd at the rate of 0.14 and 0.27% (g/g). The objective of this study was to accelerate the ripening process of Monterey Jack goat milk cheese. Cheeses were stored at 4° to 5°C for 30 weeks and rheological properties were determined using an Instron Testing Machine. The force required to measure cheese hardness at 20% compression for the first cycle increased significantly after 12 week of aging. However, the force required to measure hardness at 75% compression during the same cycle did not differ. Similarly, the force required to measure cheese hardness at 20% compression for the second cycle increased significantly during aging while the force for the 75% compression did not differ. The mean elasticity values did not increase significantly at either 20% compression or at 75% compression during aging.

Key Words: Goat cheese, Rheology, Ripening

432 Effect of cheese making conditions on texture of Arza-Ulloa cheese during ripening time. M. Almena-Aliste*^{1,2}, Y. Nöel¹, and A. Cepeda Sáez², ¹*INRA, Dairy Technology and Analysis Research Unit, Poligny, France,* ²*Hygiene and Inspection of Foods, Faculty of Veterinary, University of Santiago de Compostela, Spain.*

The effects of 7 technological factors (CaCl₂ addition of milk - Starter dose - Coagulant type - Coagulant dose - Salting conditions - Curd washing - Pressing time) on texture of Arza-Ulloa cheese (NW-Spain) were studied by using a fractional design. The effects were evaluated on experimental cheeses at 3 ripening ages (0, 2 and 5 weeks) based on

physico-chemical, proteolysis and rheological analyses. Each technological factor was studied at two levels, except the factor *salting conditions* which had three levels: *milk, curd, brine*, differing by stage of addition and concentration of salt used. Salting conditions followed by curd washing had the most pronounced effects on the formation of textural quality. These factors had a dominant effect on the cheese characteristics at each ripening time through their effect on the formation of cheese basic structure, especially on the interactions between proteins - minerals - water. Starter dose and coagulant type and dose influenced cheese properties but their effects were less intense and more dependent on ripening time. The results suggest that calcium addition and pressing time could modulate the effects of salting, curd washing and coagulant dose, through compensatory effects on basic cheese structure. Finally, the effects of the technological factors on characteristics and variability of product are been modulate by the ripening phenomena. The experimental design allowed to estimate the main linear effect of the technological factors on the characteristics of cheese. The multidisciplinary approach applied in this study and the integrated interpretation of results contribute to improve knowledge of the mechanisms that determine the development of cheese texture.

Key Words: Textural Quality, Cheesemaking conditions, Ripening time

433 An empirical method for cheese yield prediction. C. Melilli¹, J.M. Lynch², S. Carpino*¹, A. Cappa³, G. Licitra¹, and D.M. Barbano², ¹*Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy*, ²*Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY*, ³*Associazione Provinciale Allevatori, Vicenza, Italy*.

Theoretical cheese yield can be estimated from the milk fat and casein or protein content of milk using classical formulae, such as the Van Slyke

formula. These equations are reliable predictors of theoretical or actual yield based on accurately measured milk fat and casein content. Many cheese makers desire to base payment for milk to dairy farmers on the yield of cheese. However, in small factories accurate measurement of fat and casein content of milk by chemical methods or infrared milk analysis are too time consuming and expensive. Therefore, an empirical test to predict cheese yield was developed using simple equipment (i.e., low-speed room-temperature swinging bucket centrifuge, analytical balance, and forced air oven). Weigh 10 ml of milk into a centrifuge tube. Add 0.1 ml of an acetic acid solution to achieve a pH of about 5.9, mix and incubate at 30°C for 10 min. Add 0.1 ml of the diluted chymosin to the tube, stopper, mix immediately for 15 seconds, and incubate at 30°C. At 30 min a firm coagulation should form. Centrifuge for 30 min at 1625 x g. There will be a curd pellet at the bottom and the sides of the tube should be free of curd and the clear whey should be particulate free without free fat at the surface. Decant the whey and quantitatively transfer the curd to a dry, tared, total solids pan. With a metal spatula, cut and spread the curd in the pan. Dry for 4 h in a 100°C forced air oven. Weigh the pan plus residue and calculate the dry curd weight as a percentage of the milk weight. A linear regression of calculated theoretical versus dry weight yields for milks of known fat and casein content was calculated. A regression of equation of $y = 1.26x + 1.58$, where y is theoretical yield and x is measured dry solids yield ($r^2 = 0.974$), for Cheddar cheese was developed using milks with a range of theoretical yield from 7 to 11.3 kg per 100 kg. The standard deviation of the difference (SDD) was 0.193 and the coefficient of variation (SDD/mean x 100) was 1.9% for 15 milks.

Key Words: Cheese yield

EXTENSION EDUCATION

434 Beef Infobase: a new brand of information exchange. R.M. Kattng*¹, W.E. Kunkle², T. Troxel³, and B.R. Eastwood⁴, ¹*University of Arizona, Tucson*, ²*University of Florida, Gainesville*, ³*University of Arkansas, Fayetteville*, ⁴*USDA-CSREES, Washington, DC*.

Today's beef industry is faced with the overwhelming task of searching for creditable answers to specific questions. Therefore, a joint effort between the USDA-CSREES, land grant universities, producer commodity groups and the private sector resulted in a virtual library of current, credible information (Beef Infobase). Infobase articles are categorized into general topics including animal welfare/behavior, annual research reports, beef quality assurance, breeding and genetics, business management, carcass and product, facilities and equipment, feeding and nutrition, grazing lands, forages, herd and animal health, herd management, industry facts and figures, marketing, reproduction, and waste and environmental management.

The Infobase consists of peer reviewed articles submitted through five regional editors (Northeast, Southeast, Midwest, Texas/Oklahoma and West). The management of the Infobase is the responsibility of the beef infobase committee, comprised of cooperative extension, producers and representatives of allied industries. ADDS Inc. publishes the Beef Infobase electronically in both CD and web format. ADDS Inc. is a non-profit educational corporation that facilitates cooperation between public and private sectors across various institutions and disciplines. The Beef Infobase has three directors on the board of ADDS Inc.

Keyword search tools are utilized to quickly locate articles. By using the Folio commands, articles can be reviewed by searching key words, or the table of contents can be searched for specific articles. Each article lists the title, author and publication origin. Over 1500 articles (from 35 states) from extension publications, university research reports, and industry experts are represented in the info base.

The process of updating, collecting user feedback, and annual product review is the responsibility of the Beef Infobase Committee members. The goal is to keep this product on the leading edge of useful technology. The Infobase is available by purchasing a CD or by subscribing to a web site (www.adds.org). Access to credible information in an easily searchable and retrievable format is an essential tool to provide situation specific answers for today's beef industry. The Beef Infobase can fulfill that need.

Key Words: beef, database, beef production

435 Dairy InfoBase: promoting cooperation, division of responsibilities and national leadership in support of dairy education. B.R. Eastwood*¹, M.F. Hutjens², M.B. Opperman³, J.M. Mattison³, and M.J. Joyce⁴, ¹*USDA-CSREES, University of Illinois, Urbana*, ²*ADDS Center*, ⁴*Wisconsin Milk Marketing Board*.

The dairy infobase is an electronic resource for information, educational programming and support for decision making by dairy producers and the agri-support industry. It is available on CD and the web as a product of the ADDS (Agricultural Databases for Decision Support) program. The national project which developed the dairy infobase is organized by twenty one subject matter domains. Domain leaders were selected from among individuals recommended by university administrators and dairy project leaders. Domain leaders work with individuals who were recommended for their expertise. Each member of a domain group is considered an editor/developer of the infobase.

The charge to each domain group is to develop a strong and useful section for the infobase. This is done by reviewing the material from the previous iteration of the product, selecting those items to be included in the new version, and recommending additional new materials to incorporate into that domain. The expected result is a section that incorporates a reviewed and selected set of the most useful material to support informed decision making related to that area of the dairy operation.

Domains addressed in the infobase include agricultural safety and health; animal care and behavior; animal health and biosecurity; buildings and facilities; business management; calves and heifers; culling; dry cows and maternity; expansion; feeding and nutrition; forages; genetic improvement; grazing; HAACP and pre-harvest food safety; human resources management; information systems, records and tests; manure, odor, waste management and the environment; marketing and policy; milking management; reproduction; and small-scale and sustainability issues.

The domains facilitate division of responsibilities for developing and updating each section of the infobase. Domain leaders become de facto national leaders for their area of expertise, providing leadership for their domain group in carrying out the development of each section of the infobase product.

Key Words: Extension, InfoBase, Database

436 Combining television and the internet for beef producer education. G. E. Selk*, S. L. Grussing, L. G. Burditt, and R. K. McClendon, *Oklahoma Cooperative Extension Service, Stillwater.*

Combining television and the internet can effectively deliver management information to cow calf producers. Oklahoma Department of Agriculture statistics indicate that over 60,000 Oklahoma beef operations have beef cows. Extension beef specialists have a challenge bringing educational material to that number of producers. Two forms of media that have the potential to reach many rural homes are television and the internet. Oklahoma State University extension animal scientists and agriculture communications faculty combine television and the internet in a novel approach to information transfer to a large number of cow calf producers. The Cow-calf Corner is a two to four minute weekly presentation of a research-based management tip on the daily television show SUNUP. Because SUNUP is broadcast on the Oklahoma Education Television Authority network, the Cow-calf Corner has a statewide audience. Producers often request more detailed information than what could be delivered in the short time on television. Therefore a Cow-calf Corner website was developed to allow producers access to more in-depth information on each topic. This allows producers that desire more in-depth information or those unable to watch the televised presentation to retrieve the information at a more convenient time. Nielsen ratings have estimated that SUNUP has a daily audience of approximately 100,000 viewers in the metropolitan areas of Oklahoma. A recent survey of rural residents of Oklahoma indicate that 45 percent of rural residents watch SUNUP occasionally and 33 percent watch the show on a regular basis. The Cow-calf Corner website has a mean of over 1600 user sessions per month. Combining the two forms of media reaches a large cow calf producer audience.

Key Words: beef, television, internet

437 Decision Model to Aid in the Retain/Replace decision for Open Breeding Stock for Beef Cattle Producers. K. H. Burdine*¹, G. Ibendahl¹, J. Anderson¹, J. T. Johns¹, and L. H. Anderson¹, ¹*University of Kentucky, Lexington.*

Cow-Calf operators face the replace/retain decision for open breeding stock on a yearly basis. Historically, recommendations have consistently favored replacement of open animals. In many situations, this recommendation may be incorrect. Often, cows which are to be culled are entering their most productive years. Replacing them with young females that require additional management inputs may not be profitable. The objective herein was to create a spreadsheet-based model to assist beef producers in evaluating the profitability of retain/replace decisions. Our model prompts the user to input age of the open cow, expected annual cost of retaining a cow in inventory, market value of the open cow, cost of a bred replacement heifer, the required rate of return, typical weaning weight of calves, a salvage value for the cow at the end of her productive life, and expected productive life of a brood cow. The spreadsheet uses these data to derive the net present value of both the open cow if retained and the potential replacement heifer. We have attempted to eliminate time bias by conducting a series of net present value calculations for ten subsequent replacements. After ten subsequent replacements, the value of additional replacements is near zero due to discounting. The action (retain/replace) that yields the greater net present value becomes the recommended action for the producer. The influence of the cow cycle is reflected through the market value of the open cow, salvage value of females, and the cost of replacement heifers. This model will allow farmers and extension personnel to more accurately evaluate the decision to replace open females.

Key Words: Management Decisions, Beef Cattle, Culling

438 Development and implementation of an interactive, hands-on summer day camp for urban youth. T. Radintz*¹, A. DiCostanzo¹, J. Reed-Boniface¹, T. Ames¹, and F.A. Ponce de Leon¹, ¹*University of Minnesota, St. Paul.*

A day camp (University of Minnesota's Farm In The City Day Camp) was established in 1999 to complement consumer education efforts by agriculture commodities. Under the theme "Every Day is an Ag Day for Everyone", representatives from commodity organizations, the Minnesota Department of Agriculture, and the Colleges of Agriculture Food and Environmental Sciences (COAFES) and Veterinary Medicine developed a 5-day summer camp for children ages five through 11. The

anticipated outcomes were: 1) to enhance the perception of animal agriculture as an important contributor to basic societal needs, and 2) to increase interest in agriculture careers. The resulting curriculum led children through an introductory day (Monday), career and activities exploration days (Tuesday and Wednesday), a farm visit day (Thursday), and a food processing and community fair day (Friday). Student-educators, COAFES majors, led children (6 students to 1 educator) through daily activities. The focus activity was feeding and caring for suckling dairy calves (a calf was assigned to one or two children), a pen of weaned pigs, and a pen of weaned lambs twice daily. This activity was established to emphasize the responsibility and discipline that farmers have when owning livestock. During the activities exploration day, children were led through a veterinarian visit, a tour of the veterinary hospital, a prairie preservation plot, a cattle pasture, and a series of activities that introduced the concept of comparative nutrition in humans and animals. During the farm visit day, children were challenged to utilize their newly gained knowledge. Activities planned during the community fair involved a sponsored picnic that permitted interaction between producers and families of the children. Summary evaluations from parents of the 191 children that participated reflected an overwhelmingly positive response to this camp. Their responses indicated that children learned positive aspects of animal agriculture while having fun in a safe and interactive environment.

Key Words: Agriculture, Education, Youth

439 Evaluating the impact of management intensive grazing schools in central Missouri. M.A. Stewart* and J.K. Rogers, *University Outreach and Extension, University of Missouri, Columbia.*

Management Intensive Grazing (MIG) offers forage, animal and natural resource benefits that make it attractive to producers. While research at the University of Missouri's Forage Systems Research Center (FSRC) documented many of these benefits for Missouri producers and literature on the subject was widely available, MIG was not being widely adopted. In 1989, a curriculum was developed for grazing schools (GS) to be held at FSRC to present MIG components and principles to producers in a classroom and field demonstration setting. In 1994, the curriculum was adapted for out state regional grazing schools (RGS) to be conducted by regional extension faculty and Natural Resources Conservation Service staff. A program evaluation on the impact of both the SWGS and RGS was conducted in the fall of 1999. The purpose was to evaluate the impact that these schools had on the adoption of MIG by livestock producers attending these schools. A survey instrument was mailed to 450 Central Missouri participants of these schools. A return rate of 31 adopted some type of managed grazing system. Of those who had not adopted a managed grazing system, time, money and lack of sufficient water supplies were given as the major obstacles to adoption. Ninety percent of respondents indicated that their level of understanding MIG was such that they could implement a system, explain it to a friend or "write a book on it". When information about respondents goals was tabulated: 74% of the respondents included natural resource goals and 77% included agricultural profitability or value added goals; 79% were at least beginning to meet their natural resource goals while 60% were at least beginning to meet their economic goals. When asked to rate the overall usefulness of the topics and materials covered in the grazing school, 93% responded good to excellent. Based on producer responses, both the RGS and SWGS have had a positive impact on the adoption, understanding and implementation of MIG.

Key Words: Management Intensive Grazing, Grazing Schools, Forages

440 The Missouri Premier Beef Marketing Program: an integrated education approach to enhance economic and production efficiency for cow-calf producers. R. L. Larson*, K. C. Olson, and V. L. Pierce, *University of Missouri, Columbia.*

The Missouri cow-calf industry represents 2.15 million beef cows making Missouri the second largest producer of feeder cattle in the United States. Most (70%) of these feeder cattle are produced on small farms (i.e., less than 100 beef cows) which represent the vast majority of cow-calf producers in Missouri (93.5%). Consumers are demanding a more consistent and higher quality beef product. Creating a system that maintains the identity of a beef animal from birth to slaughter while allowing information feedback to the genetic decision-maker is paramount

to delivering a product of higher and more consistent quality. There has been growth in value-added, identity-preserved businesses in the beef industry which facilitate marketing systems of this type. Unfortunately, small and medium sized beef farms have difficulty in attracting buyers from these alternative marketing systems when only small numbers of animals can be offered for sale at a given time. The purpose of the Premier Beef Marketing Program is to help small and medium sized beef farms learn how to participate in these identity-preserved ventures which provide a high-quality beef product to consumers. The participating producers develop production and marketing criteria that all members can first agree upon and then implement. These criteria include similar genetics, health, and husbandry practices, both prior to weaning and during a short commingled feeding/stocker period following weaning. Producers learn how to interact as a group to explore alternative marketing opportunities and negotiate prices. By capturing growth and carcass information through negotiated agreements, producers learn how to interpret feedlot gain and efficiency data as well as carcass yield, yield grade, and quality grade and explore the potential impact of making changes in their operation on future profits. To date, four groups have formed and sold 1,154 yearling calves in 1999-2000.

Key Words: marketing, cooperative, information feedback

441 Dairy employer experiences with Hispanic workers in New York State. T.R. Maloney*, *Cornell University, Ithaca, NY.*

In recent years there has been an increasing number of Hispanic workers employed on New York dairy farms. In 1999 survey interviews were conducted with 20 New York dairy farm managers who employ Hispanic workers. The purpose of the survey was to benchmark current employment practices on New York dairy farms where Hispanic workers are employed. The survey questionnaire examined a variety of employment related issues including language differences, recruiting patterns, wages, transportation, housing and cultural issues. The dairy employers interviewed have been very resourceful in recruiting and managing Hispanic workers. Despite linguistic and cultural differences employers found positive ways to manage Hispanic employees. While most working relationships with Hispanic employees have been positive, several challenges exist. Solving the language problem is the greatest initial challenge, since few Hispanic workers speak English. In addition, managers must understand cultural differences to avoid misunderstandings and interpersonal problems. Employers reported other challenges including illegal immigration, community relations and employee turnover. Based on this survey, dairy farm employers who successfully manage Hispanic employees possess the following characteristics: 1) They work aggressively to overcome the language barrier. 2) They make considerable effort to learn about the culture of their employees. 3) They develop a business culture that accepts and appreciates the differences that individual employees bring to the workplace. 4) They establish employment policies and carefully communicate them to all employees. 5) They make every effort to hire Hispanic employees who have legally entered the United States. 6) They acknowledge their employees strong family ties and desire to return home for extended periods of time. 7) They help create and support social and recreational activities that will create a quality of life outside the job. 8) They help employees become oriented to the community.

Key Words: Hispanic worker, human resource management, multicultural workforce

442 HACCP at the Dairy Farm. J.K. Reneau*¹ and W.E. Coleman², ¹University of Minnesota, St. Paul, ²Dairy Consultant, Fargo, ND.

Eleven Minnesota dairy farms were enrolled in a descriptive survey January 1998. The purpose of the project was to: explore the practical application of HACCP plans on dairy farms; determine what may be the critical control points; and determine what samples and at what frequency samples should be collected. The farms ranged in size from 40-1200 milking cows. Minnesota State Department of Agriculture field staff inspected the dairies each month for 1 year. All official inspection reports, SCC, and bacteria reports were compiled. Milk plant component testing (SCC, % BF, % solids, % lactose) done for each bulk tank pick-up was collected. On 3 of these farms this data was electronically transferred via electronic bulletin board at the milk-testing lab to process control charting software at the farm. This information feedback

to the farm manager was used to maintain or improve milk quality. Monthly visits were made to all project dairies by project researchers to collect BT milk samples, individual cow milk samples for all clinical cases, and bedding samples. Monthly bulk tank milk samples were cultured for the presence of human food-borne pathogens (*Salmonella*, *Listeria*) and bovine mastitis pathogens. Bedding samples were also cultured for the presence of mastitis pathogens. Over one million bulk tank temperatures were recorded at 5-minute intervals and stored in data loggers for the 1-year duration of the project. While analysis is not yet complete, preliminary analysis shows that: bulk tank cooling and wash temperatures are critical control points; daily use of bulk tank SCC data in process control charts is an effective aid in motivating dairy personnel to maintain or improve the process of producing quality milk; *Listeria* was not isolated from any of these dairy's monthly bulk tank samples; 3 *Salmonella* isolates were found from the monthly bulk tank milk of 2 of the project dairies; and bedding cultures were useful for decisions on bedding frequency. Bulk tank cooling temperature, bulk tank wash temperature, bulk tank SCC, bulk tank bacteria counts, and bedding bacteria counts appear to be important outcome indicators of the management practices governing quality milk production.

Key Words: HACCP, Critical Control Points, Management Practices

443 Differences between dairy nutritionists and veterinarians and the effect on educational strategies. G.R. Oetzel*, *University of Wisconsin, Madison.*

Veterinarians and nutritionists are increasingly working together and assuming overlapping roles in servicing dairy clients. Correspondingly, educational programs are being targeted at both nutrition and veterinary audiences. An understanding of the educational and operational differences between these two groups of dairy professionals may improve the effectiveness of educational programs designed for both groups. Veterinarians work primarily with the outliers in the herd management system - individual animals with health problems. Nutritionists are more attuned to central tendencies of herd performance. Veterinarians are trained to always make at least a tentative diagnosis and initiate treatment, even when the diagnostic data are incomplete or obscure. Nutritionists tend to be less likely to make diagnostic decisions in response to unclear problems in herd performance. Veterinarians are generally trained to find a single cause of an animal's health problems and may be uncomfortable with multi-factorial causes of herd-based problems. Nutritionists are typically more comfortable integrating multiple causes of herd problems. Veterinarians often deal in realms of high mystique (e.g., pregnancy diagnosis or life-and-death clinical decisions) and thus are afforded disproportionately high standing with dairy producers. Nutritionists generally have a less secure position with their clients and may be more cautious for fear of making a mistake. Veterinarians are more likely to be given the benefit of the doubt by producers and may be bolder to implement herd changes. Nutritionists often focus on shorter-term production goals in a herd, while veterinarians are more likely to be concerned with longer-term issues of cow health, longevity, and culling. The differences between nutritionists and veterinarians are complementary. Dairy herd profitability and educational programs are most successful when veterinarians and nutritionists understand each others' situations and work cooperatively.

Key Words: Nutritionists, Veterinarians, Educational strategies

444 California dairy quality assurance program environmental stewardship certification process. D. Meyer*¹, D. Wilson², S. McGinnis², M. Payne¹, and G. Vesperat¹, ¹University of California, Davis, ²California Department of Food and Agriculture.

Three requirements must be completed for environmental stewardship certification: completion of a six hr short course on environmental stewardship, development and implementation of an environmental stewardship farm plan, and successful completion of a non-regulatory, third party evaluation. Participation in the certification process is voluntary. The three classes of the short course are offered in the fall and spring. Classes need not be taken in sequence. The course addresses the top 20 problems regulatory agencies staffs have with dairy operations. The environmental stewardship farm plan consists of: estimation of winter liquid storage requirements including runoff and existing storage capacity, completion of risk assessment documents and creation of an action plan associated with high risk categories, a storm water pollution prevention plan, an emergency manure management plan and required documents

for local, regional and state permits. Producers request the third party evaluator. This individual reviews farm documents and walks through the facility to determine if the management and the facility are capable of being in compliance with regulations. A grant from U.S. EPA is covering the cost of the first 950 dairies that request the third party evaluation.

Key Words: Dairy, Manure, Management

445 A study on the demography of milkers in Pennsylvania and their influence on milk quality. C. Burns*, D. Wolfgang, and B. Jayarao, *Pennsylvania State University, University Park.*

Changing trends in the production of food and fiber is causing major concern with ag-industries. A questionnaire was administered by PA DHIA personnel to determine current demographics for milkers in Pennsylvania, their education levels, and standard milking practices on the farm. A total of 115 farms representing 319 milkers participated in the survey. Most dairies surveyed have less than 100 cows (mean; 71 cows/herd), About 5% of farms had written protocols for milking. There was no evidence of common milking techniques among the farms surveyed, except for the use of paper towels for wiping and drying teats. The average milker was more than 35 years old with a highschool education and little off-farm training on proper milking technique. Many milkers (31%) were asked to make suggestions for improving farm's milk quality. The majority were asked to report health problems with herd cattle, and had access to the PA DHIA records (64%), but few received any financial rewards toward their efforts (12%). The findings of the study indicated a need to improve existing, and develop new training programs focused on issues related to milking management practices, milk hygiene, and labor relations.

Key Words: Demographics, milkers, milk quality

446 DairyNew: An Internet-based electronic mail distribution system for dairy production related newsletters. M.A. Varner*¹, S.W. Fultz¹, and K.E. Olson², ¹*University of Maryland, College Park*, ²*American Farm Bureau Federation.*

An automated electronic mail (e-mail) distribution system was devised for dairy production newsletters. L-Soft ListservTM e-mail software (Ver. 1.8c) running on an IBM mainframe computer was used to establish a centralized distribution address in 1995 for distribution of newsletters in electronic format. Individual articles of national/international interest from 27 public-sector and two private-sector newsletters listed in the World Wide Web Virtual Library for Dairy Production (www.ansi.okstate.edu/library/dairy/pub-coll.htm) were selected and classified according to content (veterinary medicine; reproductive management; nutrition and feeding; mastitis and milking management; economics and dairy farm finances; facilities and engineering; replacements and calves, genetics; and grazing and pastures). Subscribers received messages from as many, or as few, of the content classifications as they wish. Newsletter editors were contacted, and all agreed in advance to allow others to redistribute the articles as long as the original source and author for the article was cited. Each subscriber must agree to adhere to this policy before they receive DairyNew messages. The source and author citation information is distributed with each article. All messages are archived, and the Listserv software allows subscribers to search for articles on specific topics, by individual authors or newsletters or within certain time frames. One hundred ninety nine newsletter articles were distributed as e-mail messages in 1999 to over 400 subscribers from over 20 countries. Subscriptions are automated, and information on the various features can be found at the DairyNew homepage (www.wam.umd.edu/markv/DairyNew.html). Use of material from additional newsletters and more subscribers are solicited.

Key Words: Dairy production, Internet, Extension newsletter

447 Silage-L: Electronically connecting the silage industry. T.E. Schmidt*, K.K. Bolsen, M.K. Siefers, and M.E. Uriarte, *Kansas State University, Manhattan.*

Agriculture relies on the experience of yesterday, the technology of today, and the speed of tomorrow. New developments in the industry stem from university research and branch out to commercial businesses, which in turn respond to producer's needs. The speed and timeliness of

delivering information is critical, especially when livelihoods depend on it. In the silage industry, there is a link between producer, researcher, and silage contractor. It is referred to as the "Silage Triangle." Kansas State University has developed a way to further, and faster, connect the Silage Triangle by creating the e-mail listserv Silage-L. Its purpose is to provide an information and technology link between university or commercial researchers, extension agents, technical advisors, consultants, silage contractors, crop growers, and dairies and feedlots. Questions, research news and ideas, job opportunities, and other information dealing with silage are submitted to the list for discussion. Discussions on production, management, utilization, microbiology, silos, evaluation, crop agronomics, economics, "band-aid" solutions, sanitation, and the environment are encouraged. Announcements of conferences, educational events and aids, and government regulations and policies are also acceptable topics of discussion. The listserv spans nationally and internationally. Members to the list receive e-mails from the list, can send their own question to the list, and can access past discussions via the archives. By providing this service to the silage industry worldwide, information transfer can go where and when it's needed.

Key Words: Silage-L, Information transfer, E-mail listserv

448 An interactive web site to help producers select the most economically desirable Holstein sire portfolio. P. R. Tozer*, G. W. Rogers, J. B. Cooper, and H. J. Oberholtzer, *Pennsylvania State University, University Park.*

An interactive website (www.das.psu.edu/grogers/sireportfolio) was developed to assist medium and large dairy producers select a portfolio of sires that would suit their economic and genetic goals. Dairy producers can compare the investment value of different portfolios of sires from various breeding companies based on the expected net revenue (ENR\$) of each bull within the respective portfolios and the risk preferences of the dairy producer. The interactive website is user initiated and requires limited information from the producer. Producers enter appropriate information on the milk market and select values for indicators of basic herd management data, such as reproductive efficiency and replacement management. Producers answer a series of questions that allows for the quantification of their view of risk in sire selection. Risk preferences determine the relative importance of the ENR\$ and the variability in ENR\$ and are critical for making the optimum choice among portfolios. Sire data are accessed directly from databases containing information on PTAs and reliabilities from the most recent sire summary. A summary page details the entire portfolio and the contribution each bull makes to the portfolio. Results are presented with and without adjustments based for risk on the preferences of the dairy producer. The website has been reviewed for ease of use and technical aspects by individual producers and industry experts. Keywords: Sire selection, investment portfolio.

Key Words: sire selection, investment portfolio

449 Field implementation of nutrition and herd management practices to reduce nutrient losses from Shenandoah Valley dairy farms. F. P. Wydner, III*¹, G. M. Jones¹, and K. F. Knowlton¹, ¹*Virginia Polytechnic Institute and State University, Blacksburg.*

A two-year field study was implemented to reduce nutrient losses from dairy farms through nutritional and herd management practices. Farm advisory teams were established, and nutrient intake and excretion, whole farm nutrient balance, herd milk yield and reproductive efficiency were monitored throughout the study. Ten collaborator herds were identified, all at state DHIA average or better for milk yield and days open. Baseline feed samples and ration information were collected for two months and analyzed for phosphorus (P) and nitrogen (N) content. Feeds were analyzed monthly, and monthly DHIA milk yield, milk composition, milk urea N (MUN), and reproductive data were obtained. Blood and fecal samples were collected from 25 cows per herd every three months to monitor P excretion and blood urea N. Individual farm advisory teams were formed to provide targeted advice, and were comprised of the owner, nutritionist, veterinarian, extension agent and other key individuals. Each farm advisory team met monthly and reviewed milk yield, milk composition, MUN content, and results of feed analyses to determine if changes were needed to reduce excess excretion of N and P. Advisory teams were used to improve communication, owner education, and implementation of needed changes, but the owner made all final

decisions. Nutrient budgets were developed for each farm for N and P at the start of the study and following ration and management changes. Ten control herds similar to collaborator herds were identified and monitored. Feed samples and intake data were collected and analyzed every three months in control herds, and milk yield, milk composition, MUN, and reproductive data recorded once per year. Control herds received this data, but no additional intervention occurred and no advisory teams were established. The goal of this project was to demonstrate the use of nutritional and management practices to reduce nutrient losses from Virginia dairy farms.

Key Words: Farm Advisory Teams, Dairy, Nutrient Losses

450 Nitrogen cycling on pasture based dairies. T.W. Downing*, *Oregon State University, Corvallis.*

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complex, because grazing animals are constantly harvesting forage and depositing manure. You also have continuous grass growth as a factor. Participates received a customized AWMP, calibration of manure handling equipment, and a detailed farm map. They also decided how they were going to measure standing forage daily and record their data. Soils samples were taken before and at the conclusion of the project to help verify and confirm the results. Farm A did not complete the yearly forage measurements. Farm B had grass yields ranging from 8743 to 20177 kg/ha with an average of 16926 ± 1959 kg. Farm C had yearly yield totals ranging from 4214 to 16254 kg/ha with an average of 8967 ± 3138 kg. Pasture protein levels varied some throughout the season, but were averaged to determine the approximate level on nitrogen removed. Total nitrogen removed per hectare by grazing ranged from 225 up to 589 kg of N/ha removed. Net nutrient balance for nitrogen was negative for thirty-one of thirty-two fields studied. Farm A continues to record manure applications by field, focusing efforts on even manure distribution. Farm B and C found this increased level of management rewarding and profitable. They also used this data to give them confidence to add commercial fertilizer. Both these farms believe this approach has made them more profitable in addition to being able to truly document agronomic applications.

Key Words: Waste management, Nutrient balance, Animal Waste Management Plan

FOOD SAFETY

451 A comparison of antibiotic resistance patterns from swine farms using or excluding antibiotics. M. Beckmann*, F. R. Jackson, and A. G. Mathew, *The University of Tennessee, Knoxville, TN.*

The effects of farm use or exclusion of antibiotics on antibiotic resistance patterns of bacteria were compared using fecal samples from live swine. Four farms that used antibiotics and three farms that excluded antibiotics from production were selected and from each farm, 6 pigs from each of 4 weight groups (4.5, 23, 45, and 109 kg) and 5 sows were randomly selected for collection of fecal samples. Non-pathogenic *E. coli*, O157:H7 *E. coli*, and *Salmonella spp.* were isolated from fecal samples and tested for sensitivity to gentamicin, sulfamethazine, oxytetracycline, ceftiofur sodium, and ampicillin using a standardized minimum inhibitory concentration (MIC) analysis. Sensitivity patterns were markedly different between farm types in non-pathogenic *E. coli*, and moderately so in salmonella. In both cases, isolates from farms that excluded antibiotics had lower ($P < .05$) MICs. The number of resistant isolates and those that demonstrated multiple resistance patterns was greater ($P < .05$) on farms that used antibiotics. Nonpathogenic *E. coli* from farms that excluded antibiotics had significantly lower ($P < .001$) MICs for gentamicin, sulfamethazine, oxytetracycline, and ampicillin and lower ($P < .10$) MICs for ceftiofur. Farm type differences were most evident for isolates from younger pigs for gentamicin, ceftiofur, and ampicillin, but were also noted among all pig groups for sulfamethazine and oxytetracycline. In salmonella, the MICs were higher from farms that used antibiotics, particularly for oxytetracycline and ceftiofur ($P < .001$). O157:H7 *E. coli* were isolated from 2 farms, both of which used antibiotics in production, thus a relevant analysis on that bacterium was not possible. In total, these data indicate that exclusion of antibiotics in swine production decreases antibiotic resistance in non-pathogenic *E. coli*, and to a lesser extent resistance in salmonellae.

Key Words: Antibiotic resistance, *E. coli*, Swine

452 Effect of drug combinations and regimens on antibiotic resistance in bacteria from swine. F. R. Jackson*, M. Beckmann, and A. G. Mathew, *The University of Tennessee, Knoxville.*

In 2 replicate trails, 144 weaned pigs were used to test the effects of antibiotic dosing schemes on resistance in bacteria. Pigs were inoculated with the foodborne pathogen *Salmonella typhimurium* prior to being treated with feed- and water-based antibiotics. Treatments included maximum label use, rotation of similar and non-similar antibiotics, increasing gradient doses, and pulse dosing of antibiotics for a period of 2 weeks following pathogen challenge. Fecal samples were

obtained prior to initiation of treatments, on various days during treatment, and throughout the grow-finish phase. The challenge organism and non-pathogenic *E. coli* were recovered from fecal samples and tested against all antibiotics used in the study to determine effects on resistance patterns. Antibiotic resistance was affected to a greater extent in non-pathogenic *E. coli* compared to *Salmonella typhimurium*. Greater resistance ($P < .0001$) occurred when similar antibiotics (apramycin, gentamicin, neomycin) were used in rotation compared to the other treatments. Significant ($P < .05$) time by treatment interactions also occurred during or just following rotational treatment with similar antibiotics compared to samples collected later and from other treatment groups. Pigs on the control and pulse dose treatments produced bacteria with lower resistance compared to other groups. These data indicate that dosing regimens affect antibiotic resistance patterns in bacteria associated with swine.

Key Words: Swine, Salmonella, Antibiotic Resistance

453 Prevalance of verotoxin-producing *Escherichia coli* in sheep grazing Great Basin irrigated pastures. S. L. Lake*, B. H. Thran, H. S. Hussein, S. F. Khaiboullina, M. R. Hall, and H. A. Glimp, *University of Nevada, Reno.*

Although sheep have never been implicated in an *Escherichia coli* associated foodborne illness, the limited research published in recent years have shown that sheep harbor verotoxin-producing *E. coli* (VTEC), including O157:H7 at high rates. This suggests that mutton, lamb, or their products share a food safety risk similar to that of beef. In most cases research has focused on characteristics (i.e. sorbitol negative and 4-methylumbelliferyl- β -D-glucuronide [MUG] negative) usually associated with *E. coli* O157:H7. However, VTEC encompass numerous serotypes of *E. coli* and are not limited to sorbitol negative; MUG negative isolates. The objective of this study was to assess the VTEC prevalence in sheep grazing an irrigated pasture over 6 months (summer and fall, 1999). Twenty yearling (15-mo old) ewes (7/8 Merino; 1/8 Rambouillet) were selected at random from a large flock (>1,000 ewes) at Rafter 7 Ranch. The ewes grazed fescue (*Festula arundinacea*) and white clover (*Trifolium repens*) pasture during the summer and were supplemented with alfalfa (*Medicago sativa*) hay during winter. Thirty-nine fecal samples were rectally collected in August and November. One ewe was lost to predation after the first collection. Initial *E. coli* isolates were selected using microbiological methods utilizing the lack of sorbitol fermentation properties of *E. coli* in conjunction with MUG. Verocytotoxicity tests were performed to determine the toxicity status of the isolates. Eleven isolates from five ewes (one from the summer and four from the fall collections) were cytotoxic. None of the isolates matched the classical identification of O157:H7 (sorbitol negative; MUG

months to monitor P excretion and blood urea N. Individual farm advisory teams were formed to provide targeted advice, and were comprised of the owner, nutritionist, veterinarian, extension agent and other key individuals. Each farm advisory team met monthly and reviewed milk yield, milk composition, MUN content, and results of feed analyses to determine if changes were needed to reduce excess excretion of N and P. Advisory teams were used to improve communication, owner education, and implementation of needed changes, but the owner made all final decisions. Nutrient budgets were developed for each farm for N and P at the start of the study and following ration and management changes. Ten control herds similar to collaborator herds were identified and monitored. Feed samples and intake data were collected and analyzed every three months in control herds, and milk yield, milk composition, MUN, and reproductive data recorded once per year. Control herds received this data, but no additional intervention occurred and no advisory teams were established. The goal of this project was to demonstrate the use of nutritional and management practices to reduce nutrient losses from Virginia dairy farms.

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FOOD SAFETY

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supplemented with alfalfa (*Medicago sativa*) hay during winter. Thirty-nine fecal samples were rectally collected in August and November. One ewe was lost to predation after the first collection. Initial *E. coli* isolates were selected using microbiological methods utilizing the lack of sorbitol fermentation properties of *E. coli* in conjunction with MUG. Verocytotoxicity tests were performed to determine the toxicity status of the isolates. Eleven isolates from five ewes (one from the summer and four from the fall collections) were cytotoxic. None of the isolates matched the classical identification of O157:H7 (sorbitol negative; MUG negative) and two isolates were sorbitol negative but MUG positive. All isolates were initially identified as sorbitol negative, but when tested by the API identification system, nine isolates were sorbitol positive. Eight isolates were MUG positive and one isolate was MUG negative. The prevalence rate of VTEC in these ewes was 5% for the summer collection and 20% for the fall collection suggesting that the infection was transient. Based on the characteristics of our isolates, *E. coli* O157:H7 was not the prevalent VTEC in grazing Nevada range land. These results also support the importance of screening sheep for VTEC instead of limiting the tests to O157:H7. Our observations agree with recent studies indicating that *E. coli* O157:H7 is not the predominant VTEC in sheep.

Key Words: Food safety, Sheep, *Escherichia coli*

454 Determining incidence levels of Salmonella and Escherichia coli O157:H7 on beef cattle. A.R. Barham^{*1}, G.H. Locke², D.M. Allen², J.R. Blanton¹, and M.F. Miller¹, ¹Texas Tech University, ²Excel Corporation.

The objective of this study was to determine the effects of a pre-slaughter warm water wash, feedlot management practices and season (summer vs, fall) on incidence levels of *Salmonella* (SM) and *Escherichia coli* O157:H7 (EC) in beef cattle. Immediately following arrival at packing facilities, treated animals received a warm water hide wash. Bacterial hide swipes were aseptically collected following exsanguination and placed in Tryptic Soy Broth (TSB) and shipped to a USDA approved microbiological laboratory (Silliker Laboratory) for microbiological assays. A second group of animals were randomly selected from 12 different feedlots from the West Texas Panhandle and were examined for bacterial contamination upon arrival at the packing facility. Feedlot variables examined were capacity and antibiotic treatments. Feedlots used in the study fed a commercially available grain based diet. Bacterial hide swipes were aseptically collected during the fall (November and December; S1) and summer (June and July; S2) to evaluate seasonal effects. Samples were returned to Texas Tech University's Meat Science Laboratory within 4 hours of sampling and analyzed utilizing USDA approved methods. Statistical analysis of data was performed with SAS CATMOD procedures. No significant differences were obtained with warm water hide washes. Significant differences were detected for SM incidence levels between feedlots ($p < .05$) but was not detected for EC. No significant differences were detected for SM or EC due to feedlot capacity or antibiotic treatment. *Salmonella* incidences were also significantly higher in S2 than S1 ($p < .05$) but no differences were detected for *E. coli*. In conclusion, feedlot and season had a large effect on SM, however antibiotic treatment and feedlot capacity did not influence these incidence levels. No effects were seen on the incidence of *E. coli* for season or feedlot management practices

Key Words: food safety, Salmonella, *E. coli*

455 Escherichia coli O157:H7 becomes resistant to sodium chlorate in pure, but not mixed culture or in vivo. T. R. Callaway^{*1}, R. C. Anderson¹, S. A. Buckley¹, M. A. Carroll², L. F. Kubena¹, and D. J. Nisbet¹, ¹USDA/Agricultural Research Service-Southern Plains Agricultural Research Center College Station, TX, ²Texas A&M University, College Station.

Sodium chlorate kills *Escherichia coli* O157:H7 via non-specific reduction of chlorate by nitrate reductase and has been proposed as an additive to ruminant diets prior to slaughter. Cells lacking nitrate reductase are chlorate-resistant, and are easily selected in pure culture. The objective of this study was to determine if chlorate-resistant *E. coli* O157:H7 strains could be selected in vivo. *E. coli* O157:H7 strains ($n=13$) were screened and all were chlorate-sensitive ($P < 0.05$) as determined by specific growth rate; but overnight chlorate-treated cultures (10 mM) became chlorate-resistant. When *E. coli* O157:H7 was incubated in sterilized fecal juice with 10 mM chlorate, CFU/ml declined from 10^6 to

10^3 in 6 h ($P < 0.05$), but returned to 10^5 by 24 h, and these cells were chlorate-resistant. When *E. coli* O157:H7 was incubated in fresh fecal fluid with 10 mM chlorate, numbers declined from 10^6 to 10^1 CFU/ml in 6 h ($P < 0.05$) and to < 10 CFU/ml by 24 h ($P < 0.05$) but these colonies were chlorate-sensitive. Continuous culture of *E. coli* O157:H7 ($D=0.05$) contained 10^7 CFU/ml that were always chlorate-sensitive ($P < 0.05$). Addition of 10 mM chlorate to the chemostat caused a transient CFU decrease, but remaining colonies were chlorate-resistant upon testing ($n=20$). Continuous culture of *E. coli* O157:H7 in fresh fecal juice had a total anaerobic population of 10^{10} cells/ml and *E. coli* O157:H7 of 10^6 CFU/ml. When 10 mM chlorate was added, the *E. coli* CFU/ml declined to 10^3 ($P < 0.05$) but no colonies were chlorate-resistant ($n=20$). When piglets ($n=30$) were challenged with *E. coli* O157:H7 and treated with 100 or 200 mM chlorate, no chlorate-resistant isolates were cultured from the ileum, cecum, colon or rectum. These results indicate that chlorate-resistant O157:H7 strains can be selected in pure, but not mixed culture and suggests that terminal chlorate feeding will not select for chlorate-resistance in vivo.

Key Words: *E. coli* O157:H7, Chlorate, Chlorate resistance

456 Tasco Supplementation in Feedlot Cattle: Effects on Pathogen Loads. L.L. Behrends, J.R. Blanton, Jr., M.F. Miller, K.R. Pond, and V.G. Allen, Texas Tech University, Lubbock.

The objective of this study was to determine the effects of Tasco-EX (extract from *Ascophyllum nodosum*) supplementation on pre- and post-harvest shedding of *Escherichia coli* (*E. coli*), *Escherichia coli* O157 (*E. coli* O157) and *Salmonella* in feedlot cattle. Forty-eight Angus feedlot steers had 0%, 1% and 2% Tasco-EX added to their conventional grain based diets on a dry matter basis 2-wks prior to slaughter. Fecal samples and hide swipes were collected from each animal prior to shipment to the slaughter facility and immediately following exsanguination at the slaughter facility. Samples were returned to Texas Tech University Meat Science Laboratory within 4 hr. of collection. Samples were analyzed for *Salmonella*, *E. coli* and *E. coli* O157 using FSIS and USDA approved protocols. Data were analyzed by ANOVA as a randomized block design and were further tested by orthogonal contrasts to determine linear, quadratic and cubic relationship of treatments. Data revealed that hide and fecal *Salmonella* levels were not significantly affected by Tasco-EX supplementation. However, *E. coli* in fecal and hide samples decreased linearly ($P < .10$) as the percentage of Tasco-EX in the diet increased. More importantly, we found that there were lower ($P < .05$) levels of *E. coli* O157 in treated animals for both fecal samples and hide swipes. In conclusion, Tasco-EX supplementation may be able to decrease *E. coli* incidence levels in feedlot cattle when administered 2-wks prior to slaughter.

Key Words: *E. coli*, *Salmonella*, Food Safety

457 Technique Differences to Enumerate and Isolate E. coli O157:H7 from Beef Hides. M. A. Carr^{*2}, L. D. Thompson¹, C. B. Ramsey¹, M. San Francisco¹, S. P. Jackson¹, and M. F. Miller¹, ¹Texas Tech University, Lubbock, ²Angelo State University, San Angelo, TX.

The objectives of this study were to compare the currently suggested USDA method and a procedure including Immunomagnetic Separation (IMS) for sensitivity in detecting *E. coli* O157:H7 on beef hide samples when time before enrichment and sample handling procedures were varied. A 2 method X 3 time/handling factorial was used to examine detection methods and pre-analysis sample handling practices. Three sterile sponges were used to aseptically sample a 7.6 cm X 38 cm area of beef hide and then halved and placed in sterile sampling bags. A total of 30 animals were sampled on 5 days. Samples were randomly assigned to a treatment group of Method 1 - Immediate (M1-I), Method 1 - Delayed Chilled (M1-DC), Method 1 - Delayed Room Temperature (M1-DRT), or the same handling practices under Method 2 (M2-I, M2-DC, M2-DRT). Immediate samples began enrichment within 4 h of sampling. Delayed samples were placed in ice chests with icepacks (DC) or without icepacks (DRT), and held at room temperature 28 h. Method 1 used current USDA procedures utilizing the BioControl Assurance EIA EHEC test kit for screening where Method 2 utilized Dynal anti-O157 magnetic beads. The Method 2 increase the likelihood of finding samples that were confirmed by O agglutination when compared to Method 1 (77.8 vs. 8.9%; $P < .05$). Immediate testing found 26 O agglutination positive samples compared to 22 positive samples by both DC and DRT.

All O positive samples from Method 1 were non-identifiable with the api 20 E test. However, of the 70 positive samples after O agglutination in Method 2, 25 (35.7%) were identified as *E. coli*. Within Method 2, immediate enrichment identified 66.7% of samples, DC 36.7%, and DRT 30.0%. By incorporating the IMS techniques with the Dynal anti-O157, the likelihood of confirming *E. coli* O157 was increased.

Key Words: Food Safety, *E. coli* O157:H7, Immunomagnetic Separation

458 Development of Beef Quality Assurance (BQA) programs for cow-calf producers: A glimpse at what worked for North Dakota. G.P. Lardy*, C.S. Stoltenow, and L. Lee, *North Dakota State University, Fargo.*

Most states have implemented a beef quality assurance (BQA) program. The beef industry in North Dakota (ND) consists largely of cow-calf producers and backgrounding operations. In 1998, development of a BQA program, which includes education and marketing components, began in ND. North Dakota's BQA program is funded jointly by the NDSU Extension Service, ND Beef Commission, ND Agricultural Products Utilization Commission, and USDA/FSIS. Other agencies involved in development of the program include the ND Stockmen's Association, ND Livestock Marketing Association, ND Veterinary Medical Association, ND State Department of Agriculture, and allied industry groups, including pharmaceutical companies that are active in the state. At least one representative of each group serves on the state BQA committee. The committee also includes ranchers, seedstock operators, feeders, veterinarians, and a sale barn owner. In 1998 and 1999, the committee spent extensive time securing funding, planning, and setting goals. Materials from several existing state programs were studied prior to the implementation. In early 1999, a program coordinator was hired and the ND BQA manual and corresponding presentation material were developed. Over 35 producer certification meetings were held across the state in the fall of 1999. Over 900 beef cattle producers were certified at these meetings, representing approximately 7.5% of ND beef cattle producers. Our most successful meetings (based on attendance) were held with the help of local veterinarians or sale barn operators. This indicates the importance of local support in determining program success. Our BQA program has been approved by the Nebraska Corn-Fed Beef Program, giving producers access to an additional market outlet and a potential premium. We believe that there are several factors responsible for the program's success including adequate funding, a producer friendly manual, involvement of local sale barns, veterinary clinics, and associated businesses in sponsoring the programs, and a team of people excited about BQA.

Key Words: Beef, Quality, Assurance

459 Reduction of fecal shedding of Enterohemorrhagic *Escherichia coli* O157:H7 in lambs by feeding microbial feed supplement. M. Lema*, L. Williams, and D. Rao, *Alabama A&M University, Normal.*

Ruminants are reservoirs of *E. coli* O157:H7 and fecal shedding of the pathogen forms the vehicle of entry into the human food chain. We studied the efficacy of *L. acidophilus*, *S. feacium*, a mixture of *L. acidophilus* and *S. feacium* and a mixture of *L. acidophilus*, *S. feacium*, *L. casei*, *L. fermentum* and *L. plantarum* in reducing fecal shedding of *E. coli* O157:H7 by sheep experimentally infected with the pathogen prior to administration with the microbials. Following oral inoculation with 10^{10} CFU of *E. coli* O157:H7, five groups of six Suffolk ram lambs were fed daily for seven weeks a basal diet without microbial supplement (control) or the basal diet with the different pure and mixed microbial supplements. Fecal sample was collected weekly and analyzed for *E. coli* O157:H7 using modified tryptic soy broth with novobiocin as a pre-enrichment broth and cefixim-tellurite sorbitol MacConkey agar (CT-SMAC) as a selective medium. *E. coli* O157:H7 was confirmed by its reaction with O157 and H7 antisera. Lambs administered a mixture of *L. acidophilus*, *S. feacium*, *L. casei*, *L. fermentum* and *L. plantarum* shed significantly lower ($P < 0.05$) total number of *E. coli* O157:H7 than the other lamb groups over the entire experimental period. *S. feacium* supplemented lambs were comparable ($P > 0.05$) to lambs fed a mixture of *L. acidophilus* and *S. feacium* in fecal shedding of the pathogen but significantly lower ($P < 0.05$) than the control lambs and those supplemented with *L. acidophilus*. Average daily gain (ADG) and gain to feed

ratio (G:F) were significantly improved ($P < 0.05$) by the mixed culture microbials.

Key Words: Enterohemorrhagic *E. coli* O157:H7, Fecal shedding, Microbial feed supplement

460 Epidemiological survey of Salmonella prevalence in Pennsylvania dairy herds. H. Aceto*, R.J. Munson, D.T. Galligan, C.E. Benson, D. Munro, and S. Rankin, *University of Pennsylvania School of Veterinary Medicine, Kennett Square.*

This ongoing survey aims to assess the herd prevalence of salmonella (S), specifically *S. typhimurium* DT 104, in PA dairies. A demographic and management survey was designed to identify risk factors for the introduction and maintenance of S infection. Microbiological samples comprise 3 separate milk filters and an environmental sample from the sick/fresh cow area. Isolation of S was by means of standard enrichment and differential plating procedures. To date, surveys are complete on 51 farms. Of those 51, 11 were positive for various S, 4 of which were found to be *S. typhimurium*. Phage-typing identified two of the *typhimurium*s as DT104, one DT208, and one "untypable". One of the DT104 isolates had the pentaresistance (ampicillin, chloramphenicol, streptomycin, sulfonamide, tetracycline) profile that often typifies DT104, and long-PCR revealed the presence of a 10 kb multiresistance gene cluster. The other DT104 was only resistant to ampicillin. Interestingly, both DT104's came from dual-enterprise producers. The DT208 isolate exhibited significant resistance (ampicillin, tetracycline, kanamycin, spectinomycin, streptomycin). The remaining untypable *typhimurium* was fully sensitive. Other serotypes of S isolated were *agona* (1), *thompson* (2), *montevideo* (1), *senftenberg* (1), *derby* (1), *anatum* (2) and *infantis* (1). The majority of which were fully sensitive, or resistant to only one antimicrobial. In most cases (10 of 11 positives), S was cultured from the milk filter. On 4 of those 10 farms, S was found on both the milk filter and in the environmental sample. Four farms were associated with more than one type of S. Collection of milk filters and an environmental sample from the sick/fresh cow area appears to be an effective means of monitoring S on dairy farms. However, S are associated with intermittent shedding, as evidenced by subsequent problems on farms initially found negative, and point-sampling is likely to seriously underestimate the true herd prevalence of S.

Key Words: Salmonella, Prevalence, Milk filter

461 Detection of verotoxin-producing *Escherichia coli* in culled beef cows. H. S. Hussein*, B. H. Thran, M. R. Hall, S. F. Khaiboullina, W. G. Kvasnicka, and R. C. Torell, *University of Nevada, Reno.*

In 1982, the clinical importance of verotoxin-producing *Escherichia coli* (VTEC) was recognized when *E. coli* O157:H7 was isolated from human stools during an outbreak of foodborne illness associated with the consumption of improperly cooked ground beef. Because slaughtered cull cows contribute significantly to the ground beef supply they are considered a food safety risk factor if they harbor VTEC. The objective of this study was to assess the prevalence of VTEC in culled beef cows (Angus, Herford, or their crossbreds) at the time of shipping to slaughter (between the months of September 1999 and January 2000). Fecal samples were rectally collected from 82 culled cows (8 to 12 year-old) representing eight Nevada ranches with average herd size of 600 beef cows, of which 10 to 20% are culled annually. The cows grazed meadow regrowth of range land forages (i.e., crested wheatgrass [*Agropyron desertorum*], bromegrass [*Bromus inermis*], and tall fescue [*Festuca arundinacea*]). Initial isolates were selected using classical microbiological methods based on sorbitol fermentation and 4-methylumbelliferyl- β -D-glucuronide (MUG) properties. Toxicity of the isolates was determined by performing verocytotoxicity tests. Cytotoxic isolates were detected in fecal samples from eight cows (one cow in each of two ranches; three cows in each of two ranches). Eighteen cytotoxic isolates were further characterized with the API identification system to clarify sorbitol fermentation. Five cytotoxic isolates matched the classical identification of O157:H7 (sorbitol negative; MUG negative) and four isolates were sorbitol negative but MUG positive. The remaining nine isolates were confirmed as sorbitol positive, one isolate was MUG negative, and eight were MUG positive. The VTEC prevalence rate ranged from 0 (4 ranches) to 30% (1 ranch). These results demonstrate that the number of VTEC-positive cows differ within a herd and the cytotoxic isolates are of different characteristics. This suggests the importance of screening beef

cattle for VTEC instead of limiting assays to O157:H7. By expanding the detection methods, chances of detecting *E. coli* are increased and possible on-farm management practices that minimize the risk of beef contamination can be implemented. These practices should improve the safety of beef entering the food chain.

Key Words: Food safety, Cull cows, *Escherichia coli*

462 A one-year investigation of prevalence of verotoxin-producing *Escherichia coli* in beef heifers grazing an irrigated pasture. B. H. Thran*, H. S. Hussein, S. F. Khaiboullina, and M. R. Hall, *University of Nevada, Reno.*

Verotoxin-producing *Escherichia coli* (VTEC) are a major cause of foodborne illnesses. In many cases, cattle were implicated as a reservoir of VTEC. Most investigations in the US focused on specific characteristics (i.e. sorbitol negative and 4-methylumbelliferyl- β -D-glucuronide [MUG] negative) associated with O157:H7. The objective of this study was to assess the prevalence of VTEC in beef cattle grazing an irrigated pasture over a one-year period. A herd of 23 yearling Angus heifers grazed grass pasture with only supplementation of alfalfa hay (*Medicago sativa*) during winter. A total of 86 fecal samples were rectally collected during four periods (spring [April], summer [July], fall [October], and winter [December] of 1999). Three heifers were excluded after the second collection for reproduction-related reasons. Using classical microbiological methods utilizing the lack of sorbitol fermenting properties of *E. coli* along with MUG, isolates were selected. Toxicity of these isolates was determined by verocytotoxicity tests. Positive cytotoxicity was detected for nine isolates from five heifers (one in the spring, summer, and fall and two in the winter collections). Four isolates matched the classical identification of O157:H7 (sorbitol negative; MUG negative). Two isolates were sorbitol negative but MUG positive. The remaining three isolates were initially thought to be sorbitol negative but were sorbitol positive (as well as MUG positive) by API identification. The VTEC prevalence rate in our herd ranged from 4.3% (summer or spring) to 10% (winter). Results indicate that VTEC-positive heifers within a herd differ in VTEC characteristics and that the infection is transient. Only one heifer tested VTEC positive in two periods (spring and summer). Recent studies indicated that *E. coli* O157:H7 was a proportion (8.2 to 40%) of VTEC isolated from cattle feces. Therefore, it is important to test beef cattle for VTEC instead of limiting the assays to O157:H7. Identification of VTEC-positive beef cattle before slaughter is a critical step in on-farm strategies to minimize the risk of beef contamination with foodborne pathogens.

Key Words: Food safety, Beef cattle, *Escherichia coli*

463 Stereochemical determination of clenbuterol residues in hogs. D. J. Smith*, *USDA ARS Biosciences Research Lab, Fargo, ND.*

Clenbuterol HCl is a β -agonist bronchodilating agent that has been used in an off-label manner to enhance the leanness of cattle and swine. Consumption of clenbuterol residues has resulted in the intoxication of humans. Cardiovascular side-effects of clenbuterol are attributed to its R stereoisomer. The objective of this study was to determine the stereochemical composition of clenbuterol residues in edible tissue of swine. Nine barrows and nine gilts were provided 1 ppm dietary [14 C]clenbuterol HCl for 7-d and were slaughtered (n = 3 per sex) with 3.7 \pm .7, 74.3 \pm .8, and 169.6 \pm .8 hour withdrawal periods, respectively representing nominal 0-, 3-, and 7-d withdrawal periods. Lung was included as an edible tissue based on published reports of clenbuterol intoxication after the consumption of pork-lung soup (World Food Chem News, 1998, 5:13). Clenbuterol was extracted, derivatized with phosgene, and quantified with GC-MS using a validated procedure (Wilson et al., 1994; JAOAC Int. 77:917). Clenbuterol D9 was used as the internal standard. Stereochemical separation was achieved with a ChiraldexTM B-DM capillary column. Elution order of clenbuterol derivatives was determined using HPLC-purified stereoisomers; stereochemical assignment was based on polarimetric measurements. Clenbuterol oxazolidone isomers were detected in the selective ion mode (m/z 243, 245, 302, 304; IS 249, 251, 311, 313) and peak areas of individual ions were summed. Stereochemical compositions were calculated from total peak areas. The stereochemical assay was validated for sensitivity and selectivity. Livers, kidneys, and lungs of 0-withdrawal hogs (n = 6) contained greater amounts of the S isomer (68.2 \pm 2.2, 57.3 \pm 1.1, and 56.3 \pm .9%, respectively) than the R isomer (31.8 \pm 2.2, 42.7 \pm 1.1, and

43.7% respectively). The stereochemical composition of clenbuterol-D9 remained constant in incurred and spiked tissue samples (48.9 \pm .2% R and 51.1 \pm .1%). In conclusion, a method was developed which allows the stereochemical determination of clenbuterol stereoisomer residues in tissues of treated animals. The method was used to demonstrate that clenbuterol isomers are retained in a stereoselective manner in edible tissues of hogs.

Key Words: Clenbuterol, Residues, Swine

464 A carbonate and alkali treatment that eliminates *Escherichia coli* from dairy cattle manure. F. Diez-Gonzalez¹, G.N. Jarvis¹, D.A. Adamovich¹, and J.B. Russell*², ¹*Cornell University, Ithaca, NY*, ²*ARS/USDA, Ithaca, NY.*

Escherichia coli persists in manure for long periods of time, and it is a potential source of water and food contamination. Most strains are harmless, but some cattle harbor pathogenic strains (e.g. O157:H7) without showing signs of infection. Viable *E. coli* counts in fresh manure (n = 25) and in farm storage tanks (n = 5) ranged from 100,000 to 100,000,000 per g. When fresh cattle feces were mixed equal parts (1 to 1) with urine, the *E. coli* counts declined, and after 10 days, the viable *E. coli* count was less than 10 cells per g manure. If feces and urine were mixed in a 2.2 to 1, a ratio typical of dairy cattle manure, the *E. coli* count did not decrease. The antibacterial activity of urine could not be explained by urea, alkaline pH, or ammonia, but the fecal urease produced carbon dioxide some of which was trapped as carbonate by the alkaline pH. When urine pH was decreased to from 8.5 to 6.0, carbon dioxide was dissipated, and antimicrobial effect was lost, even if the pH was re-adjusted to 8.5. *E. coli* K-12 and O157:H7 cultures that were treated with sodium carbonate (100 mM, pH 8.5, 24 h) did not persist, and dairy cattle manure (feces to urine ratio of 2.2 to 1) that was supplemented by sodium carbonate addition (8 g/kg, 5 days) had *E. coli* counts less than 10 cells per g. If the manure pH declined, the carbonate treatment was not always effective, but pH declines could be prevented by sodium hydroxide. When sodium hydroxide was included (2 g/kg), sodium carbonate additions could be decreased (4 g/kg), and treatment time was still only 5 days. Water dilution (3-fold) did not diminish the effectiveness of the carbonate/alkali treatment, and viability was still less than 10 cells per g. Based on 14,000 kg manure per cow per year, the treatment cost could be less 10 dollars per year per dairy cow.

Key Words: *Escherichia coli*, Manure, Carbonate

465 *Lactobacillus* spp. prevent *Salmonella enteritidis* colonization in chicken intestine. L.Z. Jin* and X. Zhao, *McGill University/Macdonald Campus, Quebec, Canada.*

The objective of this study was to evaluate the capability of the highly adhesive *Lactobacillus* strains to prevent the attachment of *Salmonella enteritidis* to chicken intestine. The six most adhesive *Lactobacillus* strains were isolated from chicken intestine and selected, based on their adherent ability and tolerance to low pH and bile. Arbor Acres broiler chicks were randomly assigned to three groups of 25 each. Chicks in group1 acted as control, and those in groups 2 and 3 were given a single strain of *L. acidophilus* MM8 (the most adherent among the six strains, 10⁹ CFU/ml) or the mixture of the 6 *Lactobacillus* strains (10⁹ CFU/ml) on day 1. On day 3, all the birds in each group were challenged with 0.5 ml of *S. enteritidis* at a concentration of 10⁵ CFU/ml. Treatment of chicks with a mixture of *Lactobacillus* significantly reduced (P < 0.05) the mean number of *S. enteritidis* in the duodenal, ileal and cecal contents 5 and 10 days after being challenged by *S. enteritidis*. Treatment with *L. acidophilus* MM8 also significantly reduced the number of *S. enteritidis* in cecal contents 5 and 10 days after challenge. More than 90% of chicks in the control group were colonized with *S. enteritidis* in ileum and cecum while *L. acidophilus* MM8 or the mixture of *Lactobacillus* reduced the cecal colonization of *S. enteritidis* to 45% and 35%, respectively; and ileal colonization to 70% and 30%, respectively. In conclusion, the ability of *L. acidophilus* MM8 or a mixture of *Lactobacillus* to reduce *S. enteritidis* colonization in chicken intestine, together with their attaching ability highlights them as suitable strains to minimize the *Salmonella* colonization in poultry production.

Key Words: Lactobacillus, Salmonella, chicken

466 Survival of naturally occurring Escherichia coli and a streptomycin-resistant strain of E. coli K-12 (ATCC 35695) during the aging period of hard cheeses made from raw milk. Alex Teo¹ and J. Schlessner*², ¹Illinois Institute of Technology, Chicago, IL, ²Food and Drug Administration, NCFST, Summit-Argo, IL.

The ability of naturally occurring Escherichia coli and a streptomycin-resistant strain of E. coli K-12 (ATCC 35695) to survive a standard cheese-manufacturing process and subsequent ripening was determined. Cheese samples made from raw milk with naturally occurring E. coli or a streptomycin-resistant strain of E. coli K-12 (ATCC 35695) were analyzed during the cheese-making process and subsequent ripening periods of 28, 60, 90 and 120 days. Presumptive levels of coliforms were monitored by using the 3-tube MPN-Lauryl Tryptose broth (LTB) method. Coliforms were then confirmed by using Brilliant Green Lactose broth (BGLB). In the 3-tube MPN method, presumptive E. coli was confirmed by using LTB-MUG. Cheese samples containing naturally occurring E. coli or the streptomycin-resistant strain of E. coli K-12 were plated and enumerated on selective media, such as MacConkey Sorbitol agar (MSA), Violet Red Bile Agar-MUG (VRBA-MUG), Biosynth Culture Medium (BCM), and Brain Heart Infusion-Streptomycin agar (BHI-strep). Naturally occurring E. coli showed a 1-2 log unit reduction from its original level in cheese made from raw milk after 60 days of aging at 7C. A further 3-4 log unit reduction in the level of the organism was observed after 180 days of aging at 7C. Streptomycin-resistant E. coli K-12 mutant was next used as a surrogate organism during the cheese-making process, and subsequent aging. Cheese made from raw milk inoculated with 10⁵ CFU per ml of streptomycin-resistant E. coli K-12 strain showed a 1-2 log unit reduction in numbers after 60 days of aging at 7C.

Key Words: Pathogenic Bacteria, Raw Milk Cheese, Aging of Cheese

467 The microbial ecology of milk powder processing via Terminal Restriction Fragment Patterns (TRFP-PCR) and the cloning and sequencing of community 16s rDNA for the identification of those TRF-fragments. A. Rife*¹, M. Pitesky¹, C. L. Kitts², and R. Jimenez-Flores¹, ¹Dairy Products Technology Center, Cal Poly State University, ²The Environmental Biotechnology Center, Cal Poly State University, San Luis Obispo, CA.

The complex microbial communities present during milk powder production are difficult to characterize. While Fatty Acid Methyl Ester (FAME), Randomly Amplified Polymorphic DNA (RAPD), and biochemical analysis are ideal for species identification of cultured isolates; they have limitations in representing the diversity and evenness of the microbial communities present during milk powder production. Therefore, we investigated the efficacy of Terminal Restriction Fragment Pattern PCR (TRF-PCR), for bacterial community analysis to observe the location and time differences in the microbial ecology of milk powder production. Community 16s rDNA was extracted, amplified, fluorescently labeled, and digested (Hae III) from raw, condensed, and powdered milk samples at the beginning, middle, and end of production runs of a central California milk powder facility during the spring of 1999. Fluorescently labeled DNA fragments were then separated and detected using capillary electrophoresis coupled to a laser-induced fluorescence detector. Results showed a clear reduction in the microbial diversity between raw, condensed, and powdered milk. TRF fragments of approximately 500 base pairs were initially identified using the Ribosomal Database Project (www.cme.msu.edu/RDP). Therefore, to better identify which TRF peaks represented which organisms the amplified community 16s rDNA was cloned and sequenced. Based on sequencing, the areas of peaks corresponding to *B. licheniformis*, *B. subtilis*, and *B. thermoleovorans* together represented in the middle of the run 26% and end of the run 31% of the total. Among non-sporeformers there were increases in the total relative area between the middle and end of the run. These peaks were identified as *Streptococcus cremoris*, *S. salivarius* and gamma Proteobacteria. However, differences in the relative areas for sporeformers and non-sporeformers did not correlate with total mesophilic plate and aerobic endospore counts. Amplification of community DNA specifically between the evaporator and spray dryer produced random amplicons that showed as a smear (100 and 900 base-pairs) instead of a typical band of approximately 500 bp. Our experiments showed that the combination of casein protein combined with heat was responsible for this problem.

Key Words: Spores in milk powder, Rapid identification, Bacillus and TRF-PCR

468 BEHAVIOUR of Listeria monocytogenes in MINAS FRESCAL cheese made with lactic acid and mesophilic starter. M.C.M. Naldini and A.Y. Kuaye, Universidade Estadual de Campinas.

The Minas Frescal cheese is a Brazilian soft cheese, very similar to the Latin American White Cheese. The high moisture content (60%) makes it an extremely perishable product, with a short shelf-life, even under adequate refrigerated storage. The Brazilian dairy industries have recently substituted the use of starter bacteria with direct lactic acid addition to improve cheese yield and texture. However, direct acidification produces a cheese more susceptible to spoilage by contaminating microorganisms, including the pathogenic ones such as *L. monocytogenes*, which is recognized as a causative agent of severe foodborne infections. The objective of this work was to evaluate the behaviour of *L. monocytogenes* Scott A in Minas Frescal cheese manufactured by the traditional procedure with addition of mesophilic starter compared to the direct acidification with lactic acid. The cheeses were artificially inoculated with *L. monocytogenes* culture (10⁹ cfu/ml) after cutting and whey drainage. Modified Oxford agar was used for *L. monocytogenes* counts and de Man, Rogosa, Sharpe agar was used for mesophilic starter counts in the cheeses after 0, 6, 12, 18, and 25 days of incubation at 5°C and 10°C. The results showed that in cheeses processed by the traditional way and stored at 5°C, the *L. monocytogenes* and starter counts remained almost unchanged, while both counts increased in the acidified cheese. At 10°C, *L. monocytogenes* and starter counts showed a slight decrease in the traditional cheese, with both counts increasing again in the acidified one. It was concluded that there was a strong inhibition of *L. monocytogenes* growth by the starter culture and therefore direct acidification shouldn't be recommended from a sanitary viewpoint.

Key Words: Minas Frescal Cheese, Acidified Cheese, *Listeria monocytogenes*

469 Properties and characterization of a monoclonal antibody for its use in screening endospores in skim milk powder. S. Fuller* and R. Jimenez-Flores, Cal Poly State University, DPTC, San Luis Obispo, CA.

The incidence of endospores in skim milk powder (SMP) is a problem since pasteurization, evaporation, and spray drying are ineffective in destroying them. Endospores are a risk in SMP because they are capable of germination and growth once the milk powder is rehydrated. Once vegetative, some organisms are capable of hydrolyzing lipids, casein, and/or starch, and fermenting lactose, all of these being detrimental to the quality of the SMP. Finding a rapid detection method for spores in SMP would be beneficial to screen the product industrially, and determine SMP quality. Detection of spores in SMP is currently conducted with traditional microbial plating, which is time consuming, inefficient and inaccurate. Our first objective was to determine the epitope of a monoclonal mouse IgG antibody (developed at NC State University). With this information, we could better evaluate the detection capabilities of our antibody and develop a rapid assay accordingly. Our second objective was to screen other spore forming strains from our spore collection. This collection of spore formers was specifically isolated from California SMP. Screening for cross-reactivity within this collection will measure the assay's applicability. We focused on the detection of spores utilizing this monoclonal antibody in an immunoassay and Western blot. We used protein extracts from the spores from our collection. This antibody does not present a strict specificity to *B. cereus*. Among the detected species were *Bacillus licheniformis*, *Bacillus pumilus* that have been proven to have high proteolytic, amylolytic and lipolytic activities. Furthermore, detection of some of the most detrimental strains to milk powder was achieved using this antibody. Enzyme Linked Immuno Sorbent Assay (ELISA) was also used to confirm antibody specificity and sensitivity. The antibody on ELISA has limited sensitivity (one million spores per gram of SMP). However, if enough information is available with regards to the specific epitope on the endospore, a more efficient procedure or antibody can be obtained. A Western blot was used to determine the size of the epitope on the spore coat of *B. cereus* (positive control). The size of the epitope is approximately 25 kDa and is currently being sequenced.

Key Words: Spores in skim milk powder, Monoclonal antibody, Bacillus

470 Safety improvement of salmon using biopreservatives. H. Zuckerman*¹ and R. Ben Avraham², ¹Technion, Haifa, Israel, ²Milouda, Ashrat, Israel.

Presence of *Listeria monocytogenes* in fresh, or even in cold smoked, salmon has become a major concern for the salmon processing industry, government agencies, and consumers. The application of bacteriocins to inhibit foodborne pathogens in general, and *Listeria monocytogenes* in particular is of great interest in the food industry. The efficacy of Microgard™200 (10% w/v) combined with Novasin™ (nisin) (0.2% w/v) (Rhodia Inc. NJ) and sodium metaphosphate (10% w/v) and Novagard™ (lysozyme) (Rhodia Inc. NJ), to inhibit *Listeria monocytogenes* and to prolong shelf life of fresh salmon was evaluated. Chilled salmon were cut into 10x5 cm pieces and were randomly assigned to untreated controls and to treated samples. Treatments were carried out by dipping samples for 1 min into the respective solution, in 3 replications, control samples were dipped 1 min into water. The ratio of salmon samples to dipping solution was 1:4 (w/v). Samples were individually overwrapped with PVC film (15 micron) on polypropylene trays, and evaluated for surface pH, color, total and *Listeria monocytogenes* microbiological counts after 0,1,2,3,4 and 6 days of storage at 4°C. Samples treated with Microgard and Novasin reduced aerobic bacteria population by 2 log (p<0.05) and increased shelf life from 2 days to about 6 days and also, eliminated completely the growth of *Listeria monocytogenes*. Bacteriocin treatment neither affected surface pH values nor the color

of the fish. Novagard was effective against *Listeria monocytogenes* but did not prolonged the shelf life of fresh salmon and affected its color.

Key Words: Safety, *Listeria monocytogenes*, Bacteriocins

471 Fate of toxigenic contaminant and nontoxigenic fungi in blue-veined cheese. S. M. El-Gindy*, Assiut University, Egypt.

Eight (8) types of local and imported Roquefort cheese samples were collected from different Egyptian markets and examined for its mold content. Danish and French samples contained only *P. roqueforti*. The Egyptian sampled was contaminated with *Asp. niger* and *Rhizopus nigricans*. Roquefort cheese curd was inoculated with spores of *P. roqueforti*, and/or *Asp. fumigatus* or *Asp. flavus*. The resultant ripe cheese was morphologically examined. The body, texture, flavor and mold growth and distribution in cheese were judged. The examination of various cheeses showed similarity of all cheeses to the well-known blue cheese. Some of the judges preferred the blue cheese inoculated with *Asp. fumigatus*. The present investigation revealed that cheeses were found to be free from and detectable amounts of aflatoxins. This could be attributed to certain factors such as ripening at low temperature, higher salt concentration, and higher acidity. Moreover, the addition of cheese starter may prevent the production of aflatoxin in cheese.

FORAGES AND PASTURES

472 High population corn grain silage in a dairy operation: A field demonstration. GA Brown*¹, ¹University of Missouri Outreach and Extension, Columbia.

The objective was to do a field demonstration to determine if there was an economic benefit of multiple plantings of high population corn grain to be harvested as silage. The silage would be forage in a NW Missouri dairy operation. The total size of the area to be planted was 2.8 hectares (ha). The plant population was estimated at 395,376 plants per ha. Normal plant population for hybrid seed corn silage is 65,000 plants per ha. The first planting was on June 8, 1999 and harvested on July 26. Plant height was 1.1 to 1.4 meters at harvest and estimated yield was 17 metric tons (t) per ha. The second planting was done on August 2. Due to dry weather conditions there was no harvest of the second planting, but samples were collected for nutritional analysis. Total seed cost per planting was 28.98 dollars at the current corn grain market price. A total estimated seed cost for hybrid seed corn for silage was 195 dollars. Samples for nutritional analysis were taken at the first planting pre and post harvest stages and 8 weeks after the second planting. The average of the samples, sample variance and sample standard deviations (Std. Dev.) of Dry Matter, Crude Protein, Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Net Energy of Lactation (NeL) and Relative Feed Value (RFV) are in the table below. Results showed that there was an economic advantage in seed cost to the high population corn grain silage. Nutritional quality and yields may not be an advantage over hybrid seed corn silage. More research is needed under different management styles and climatic conditions to determine if there is a benefit to using high population corn grain silage as forage in dairy rations.

Key Words: Dairy Ration, Corn Silage, Economic

473 Effect of corn silage containing high oil, waxy, multileaf, or bm3 corn genetics on feed intake, milk yield, and milk composition of dairy cows. V. R. Moreira*¹, J. Jimmink¹, L. D. Satter¹, J. L. Vicini², and G. F. Hartnell², ¹US Dairy Forage Research Center, USDA-ARS, Madison, WI,, ²Monsanto Co., St. Louis, MO.

This trial was part of a larger three-site experiment to evaluate corn silage hybrids. This part of the experiment involved 144 cows in early lactation. Following a 2-wk covariate period, 72 cows were assigned to one of six treatments for a 28-d treatment period. A second group of 72 cows followed the same protocol. The five hybrids evaluated were Cargill brown midrib 3 (BMR), Mycogen multileaf-TMF99 (TMF), Asgrow high

oil RX 5888TC (HOC), Asgrow waxy RX 5888WX (WX), and Asgrow RX 5888 (Control). Diets contained 50% forage and 50% concentrate, except for one trt (BMRH) that contained 65% forage and 35% concentrate. The forage portion of the diets contained 75% corn silage and 25% alfalfa silage. Main ingredients in the concentrate were high moisture shelled corn, cotton seed, Soyplus®, and soybean meal. Diets were similar in NDF content (average: 30.5%), except for the BMRH, which was 34.5%. Dietary CP averaged 18.6%. Milk production was greatest with BMR and differed from the control, BMRH, and HOC trts (P < .04). FCM was greatest for the BMRH trt, reflecting the much higher fat test. Milk protein percent was lowest for the BMRH. Unreplicated estimates of silage and grain yields are presented.

Item	Control	BMR	BMRH	HOC	TMF	WX	P <
Milk, kg/d	34.9 ^c	36.0 ^a	34.9 ^c	35.1 ^{bc}	35.6 ^{abc}	35.8 ^{ab}	.04
Milk fat, %	3.29 ^b	3.15 ^b	3.77 ^a	3.29 ^b	3.15 ^b	3.31 ^b	.001
Milk CP, %	3.30 ^{ab}	3.27 ^{ab}	3.16 ^d	3.24 ^c	3.31 ^a	3.26 ^{bc}	.04
DMI, kg/d	21.1	21.0	21.1	21.0	21.3	21.5	NS
3.5% FCM, kg/d	33.8 ^{bc}	33.3 ^c	36.0 ^a	34.0 ^{bc}	33.1 ^c	34.6 ^b	.05
Silage yield, T/ha	21.7	21.0	...	23.0	20.9	23.9	...
Grain yield, kg/ha	11625	11050	...	10487	9524	12921	...

Key Words: Corn silage, Milk, Corn genetics

474 Effect of level of surface-spoiled silage on the nutritive value of corn silage diets. L. A. Whitlock*, T. J. Wistuba, M. K. Siefers, R. V. Pope, and K. K. Bolsen, Kansas State University, Manhattan.

Twelve ruminally cannulated crossbred steers were used to determine the effect of level of surface-spoiled silage on DM intake and nutrient digestibilities of whole-plant corn silage-based diets. Irrigated corn was harvested at the 80% milkline stage of maturity and chopped to a 10 mm particle length. A pilot-scale bunker silo, 0.9 m in depth, and a 2.8-m diameter AgBag® were filled with alternating loads of chopped forage. After 90 d, the bunker was sealed with a single sheet of polyethylene, and this silage was designated "spoiled". The silage in the AgBag® was designated "normal". The four experimental diets contained 90% silage and 10% supplement (DM basis), and the proportions of silage in the diets were: a) 100% normal; b) 75% normal:25% spoiled; c) 50% normal:50% spoiled; and d) 25% normal:75% spoiled. The diets were fed once daily at 0700, and the amount fed was adjusted so that approximately 10% of the as-fed diet was in the feed bunk at the end of each 24-h period. The metabolism study consisted of two, 17-d periods,

and total fecal collections were used to determine nutrient digestibilities. The pH value, DM %, and NDF, ADF, and ash contents (% of the DM) were 3.90, 38.0%, and 42.6, 23.4, and 5.3%, respectively, for the normal silage and 4.80, 26.4%, and 49.0, 31.0, and 9.1%, respectively, for the surface-spoiled silage. Crude protein digestibility decreased ($P < .05$) in a linear manner as the proportion of surface-spoiled silage increased from 0 to 75% of the silage portion of the diet. Steers consuming the normal silage diet had higher ($P < .05$) DM intake and higher DM, OM, NDF, and ADF digestibilities than those fed the three diets that contain surface spoilage. The addition of surface-spoiled silage had large negative associative effects on DM intake and DM, OM, and fiber digestibilities; the largest decrease in digestibility occurred with the first increment of spoiled silage. Visual appraisal of the forage mat in the rumen indicated that its physical integrity was partially destroyed by even the lowest level of surface-spoiled silage in the diet.

Key Words: Silage, Surface spoilage

475 The effect of delayed filling and application of a buffered propionic acid-based additive on the fermentation of barley silage. J. A. Mills¹, A. G. Whiter¹, C. L. Myers², and L. Kung, Jr.¹, ¹University of Delaware, Newark, DE, ²Kemin Industries, Inc., Des Moines, IA.

Whole plant barley (early dough) was cut and wilted to 37% DM. Forage was chopped and immediately ensiled untreated (TRT 1), or treated (TRT 2) with KI-112 (0.1% of wet forage; buffered propionic acid, acetic acid, benzoic acid, and sorbic acid, Kemin Industries, Inc., Des Moines, IA). Portions of the chopped forages (untreated, TRT 3 and treated, TRT 4) were left in piles at about 25°C for 24 h before ensiling (delayed filling). A portion of untreated forage from TRT 3 was also treated with KI-112 as described (TRT 5), before ensiling. All treatments were ensiled in quadruplicate 20-l silos. Delayed filling increased the numbers of yeasts ($P < 0.05$) by more than 1000-fold (TRT 3-5), decreased ($P < 0.05$) water soluble carbohydrates ($> 50\%$), increased ($P < 0.05$) NH₃-N ($> 40\%$), and increased pH (> 1 unit). The changes in these later measurements were less ($P < 0.05$) in forage that was treated with KI-112 at chopping (TRT 4). After 60 d of ensiling, untreated (TRT1) and treated silages (TRT2) were similar in their concentrations of fermentation products, but DM recovery was greater ($P < 0.10$) in TRT silage (98.0%) than in TRT1 silage (91.3%). Silages that were delayed in filling (TRT 3-5) were higher ($P < 0.05$) in pH, lower ($P < 0.05$) in lactic acid content, higher ($P < 0.05$) in NH₃-N content, and lower in acetic acid content than silages that had been ensiled immediately after chopping (TRT 1-2). Delayed filling resulted in a clostridial fermentation as the butyric acid content was greater ($> 1.65\%$, DM basis) in TRT 3 to 5 than in TRT 1 and 2 ($P < 0.05\%$). The increase in pH and NH₃-N was less in TRT4. Delayed filling of silos has severe negative consequences on the composition of forage before and after ensiling. Treating barley forage with a buffered propionic acid preservative immediately after chopping improved the DM recovery of silage and lessened, but did not prevent, the negative effect of delayed filling on some end products of fermentation.

Key Words: Silage, Propionic acid, Delayed Filling

476 The effect of varying doses of a buffered propionic acid-based preservative on the fermentation and aerobic stability of barley silage. J. M. Neylon¹, L. Kung, Jr.¹, C. L. Myers², N. K. Ranjit¹, and J. M. Robinson¹, ¹University of Delaware, Newark, DE, ²Kemin Industries, Inc., Des Moines, IA.

Whole plant barley (wilted to 39% DM) was chopped and treated with low application rates of a preservative (KI-126) that contained propionic acid, ethoxyquin, BHT, BHA, and calcium silicate (Kemin Industries, Des Moines, IA). Treatments at the time of ensiling were: 1) no additive, 2) KI-126, 0.1% of fresh forage weight, 3) 0.15% KI-126, and 4) 0.2% KI-126. At ensiling, addition of KI-126 increased the concentration of propionic acid from 0.02% in untreated forage to 0.18, 0.38, and 0.50% in treatments 2, 3, and 4, respectively. Triplicate 20-l silos were prepared for each treatment and forage ensiled for 87 d at 20 to 24°C. Addition of KI-126 resulted in a lower ($P < 0.05$) silage pH (average 3.93) than in untreated silage (4.03). These findings were supported by numerically higher amounts of acetic and lactic acids in silages treated with KI-126 than in untreated silage. The ammonia content was not different among treatments. Numbers of yeasts were more than 10-fold less ($P < 0.05$) in treated silages and was 4.97 (\log_{10} cfu/g of silage),

3.72, 3.61, and 3.86 for treatments 1, 2, 3, and 4, respectively. Aerobic stability was defined as the number of h prior to a 2°C rise in temperature of a 3-kg sample of silage after exposure to air (ambient temperature about 20 to 23°C). Aerobic stability was improved ($P < 0.05$) with the addition of all levels of KI-126 and was 58, 83, 89, and 95 h, for treatments 1 through 4, respectively. Aerobic stability was also determined on TMR comprised of 30% (DM basis) barley silages, 30% alfalfa haylage, and 40% concentrate. Combining treated barley silages into a TMR comprised of untreated alfalfa silage containing a high concentration of yeasts (5.44 \log_{10} cfu/g) did not improve the aerobic stability of the TMR. The data from this study shows that treating barley silage with low application rates of a propionic acid-based additive improved the aerobic stability of silages but not of a TMR containing untreated silage.

Key Words: Propionic acid, Aerobic stability, Silage

477 *Lactobacillus buchneri* and enzymes improves the aerobic stability of high moisture corn. C. C. Taylor¹, J. M. Neylon¹, J. A. Lazartic², J. A. Mills¹, R. M. Tetreault¹, A. G. Whiter¹, R. Charley², and L. Kung, Jr.¹, ¹University of Delaware, Newark, DE, ²Biotol Canada, Ontario.

The objective of this study was to evaluate the effect of various doses of *L. buchneri* (Biotol, Inc., Eden Prairie, MN) and the combination of *L. buchneri* (LB) with *L. plantarum* (LP) on the fermentation and aerobic stability of high moisture corn. High moisture corn (27% moisture) was ground and ensiled in lab silos with the following treatments: 1) no bacteria, 2) LB2 (final dose of 1×10^5 cfu/g of fresh corn), 3) LB3, (5×10^5 cfu/g of fresh corn), 4) LB4 (6.6×10^5 cfu/g), 5) LB5 (1×10^6 cfu/g), and 6) LBLP (5×10^5 cfu of LB and 1×10^5 cfu of LP per g of fresh corn). All treatments also supplied the following enzymatic activity (IU/ton of wet corn): β glucanase (63,636), α amylase (31,818), xylanase (34,545), and galactomannanase (5818). Inoculation had minor effects on the products of fermentation during the early stages of ensiling. However, after 92 d, LB treatments had numerically greater concentrations of acetic acid than did untreated corn. Specifically, corn treated with the highest dose of LB (treatment 5) had more ($P < 0.05$) acetic acid (0.78%, DM basis) than did untreated corn silage (0.45%). Numbers of yeast were $3.25 \log_{10}$ cfu/g in untreated corn and tended to decrease with increasing doses of LB to a low of $2.12 \log_{10}$ cfu/g ($P < 0.05$) in treatment 6. Total lactic acid concentration was lowest ($P < 0.05$) in corn treated with the highest concentration of LB (LB5) when compared to untreated corn. Dry matter recovery ranged from 96.5 to 98.9% and did not differ among treatments. Aerobic stability (number of h prior to a 2°C rise in temperature) was markedly improved by the addition of LB when applied at a dose of 5×10^5 or more cfu/g. Aerobic stability for d 92 corn was 47, 79, 333, 400, 372, and 306 h for treatments 1, 2, 3, 4, 5, and 6 respectively. Addition of LB did not affect the rate of fermentation in high moisture corn but after prolonged fermentation, increased production of acetic acid and markedly improved aerobic stability.

Key Words: *Lactobacillus buchneri*, Aerobic stability, High moisture corn

478 Effect of Maturity and Mechanical Processing of Corn Silage on Total Tract Starch Digestibility of Corn Silage Based Total Mixed Rations. L.M. Johnson¹, J.H. Harrison¹, D. Davidson¹, B. Mahanna², and K. Shinnors³, ¹Washington State University, ²Pioneer Hi-Bred Int'l Inc., Johnston, IA, ³University of Wisconsin, Madison.

Three total collection metabolism studies were conducted over two consecutive years to evaluate the effect of maturity and mechanical processing of corn silage on total tract starch digestibility in lactating Holstein cows. Experiments 1 and 2 were conducted using Pioneer hybrid[®] 3845 corn silage, and Experiment 3 was conducted using Pioneer hybrid[®] Quanta corn silage. During 1996 Pioneer hybrid[®] 3845 corn silage was harvested at three maturities (dough - 25% DM, 1/3 milkline - 28% DM, and 2/3 milkline - 28% DM). During 1997 Pioneer hybrid[®] 3845 and Pioneer hybrid[®] Quanta corn silages were harvested at three maturities (1/3 milkline - 27% DM and 34% DM, 2/3 milkline - 33% DM and 41% DM, and blackline - 38% DM and 47% DM, respectively). At all maturities, corn silage was harvested with and without mechanical processing (John Deere 5830 harvester with kernel processor). The experimental design was a 6 x 6 Latin square. The 18 TMRs consisted of similar

feed ingredients and composition (13.2% alfalfa hay, 13.6% whole cottonseed, 26.8% corn silage, and 46.4% grain mix) differing only in corn silage treatment. Starch content was measured on TMR, Orts, and feces. Starch apparently digested in the total tract was greater for cows fed processed corn silage in seven out of nine comparisons, and similar to unprocessed corn silage in the other two comparisons. At advanced stages of maturity processing enhanced starch digestion to a greater extent than with less mature silages (Experiment 2 - 2/3 milkline (P < 0.0003), blackline (P < 0.02), Experiment 3 - 2/3 milkline (P < 0.0073), blackline (P < 0.01).

Total Tract Starch Digestibility Estimates (%)

Maturity	Dough	1/3 Milkline	2/3 Milkline	Blackline	SE				
Proc	Un- Proc	Un- proc	Un- proc	Un- proc	Un- proc				
Exp. 1	98.2	97.4	97.6	96.7	97.7	97.9	...	...	0.42
Exp. 2	...	...	98.2 ^a	98.2 ^a	98.1 ^a	95.6 ^c	96.9 ^b	95.6 ^c	0.42
Exp. 3	...	...	97.5	97.1	97.4	96.4	97.6	96.6	0.28

^{a,b,c} P < .02

Key Words: Corn Silage, Starch Digestibility, Rations

479 Effect of two corn hybrids, with or without kernel processing, on milk production. V. R. Moreira^{*1}, L. D. Satter¹, and M. I. Endres², ¹U.S. Dairy Forage Research Center, USDA-ARS, Madison, WI, ²Mycogen Seeds, Eagan, MN.

Two Mycogen corn hybrids (TMF2662 and TMF108) were chopped at 37-40% DM and a theoretical cut length of 9 to 19 mm. The longer cut silage was rolled through a processor mounted on the forage harvester with roller spacing of about 1 mm. Control and processed silages had similar particle size distribution. Sixty-four early lactation Holsteins were fed once daily with a TMR containing one of the four treatment corn silages. This completely randomized 2 x 2 factorial design was conducted for 124 d. Diets contained 37.5% corn silage, 12.5% alfalfa silage, 26.0% high moisture shelled corn, 11.6% roasted soybeans, 5.8% soybean meal, and other minor ingredients. Dietary NDF and CP averaged 27.1 and 18.0%, respectively. Grain contents (% DM) for TMF2662 and TMF108 silages were 43 and 48%. The TMF108 treatment resulted in a lower milkfat test. Processed TMF108 had the highest milk production. Processing tended to increase milk production and decrease grain in the feces.

Item	TMF2662 Control	Pro- cessed	TMF108 Control	Pro- cessed	P <
Milk, kg/d	40.6 ^b	39.6 ^c	40.5 ^b	42.4 ^a	.05
3.5% FCM, kg/d	36.9 ^b	36.9 ^b	33.9 ^c	37.9 ^a	.03
Milk fat, %	3.03 ^a	3.11 ^a	2.51 ^c	2.95 ^b	.05
DMI, kg/d	24.4 ^a	23.9 ^b	21.9 ^c	23.8 ^b	.05
FCM:DMI	1.52 ^b	1.54 ^{ab}	1.55 ^{ab}	1.57 ^a	.02
Digest. NDF, %	53.6 ^a	51.8 ^{ab}	53.7 ^a	49.0 ^b	.05
Corn kernels, % of fecal DM	3.37 ^a	.89 ^b	1.59 ^{ab}	.84 ^b	.001
SCM, kg/d	35.0 ^a	35.0 ^a	32.8 ^b	35.6 ^a	.008
Ruminal acetate, molar %	63.4	61.6	60.8	59.2	.05
Ruminal propionate, molar %	22.3	24.5	25.5	23.7	NS
Ruminal butyrate, molar %	9.8 ^b	10.1 ^{ab}	9.0 ^b	11.8 ^a	.04

Key Words: Corn silage, Kernel processing, Milk

480 Effect of Mechanical Processing of High Moisture Corn Silage on Loss of Effluent. J.H. Harrison^{*1}, D. Olson¹, J. Hay¹, and D. Davidson¹, ¹Washington State University, Puyallup.

Whole plant corn silage (Pioneer Hybrid 3845) was harvested at the dough stage of maturity (DM% = 23) as either mechanically processed or unprocessed forage. Forage was chopped at 19 mm TLC with a John Deere 5830 self propelled forage harvester equipped with a mechanical processor. The roller setting was set at a 1mm gap for processed forage. Forage was ensiled in duplicate 1.2m x 1.2m (hxd) cylindrical silos and

the top surface was weighted with 308 kg/m² of top surface. A hole of approximately 10 mm was made mid center and on the bottom of the silo for daily collection of effluent. The initial packed density of the forage as 610 kg/m³. Daily measures were made of effluent loss and DM of effluent. Data is summarized in the table below. No difference was observed in the DM % of the effluent and averaged 6.3% during the first 39 days of observation. Mechanical processing increased loss of effluent/909kg forage by 25 kg (through first 95 days of observation), and increased loss of DM/909kg forage in effluent by 1 kg (first 39 days of observation).

Treatment	%DM of effluent*	Kg Effluent loss/ 909Kg Forage**	Kg DM loss in effluent/ 909 Kg Forage*
Processed	6.03	67.55	2.25
Unprocessed	6.64	42.12	1.24
SE	.155	1.256	.0665
P <	.11	.005	.009

*Average of first 39 days of observation. **Average accumulative loss in first 95 days of observation.

Key Words: Corn Silage, Forage, Effluent

481 Relationship between NDF and hay intake in horses: A review of published studies. A. C. St. Lawrence^{*}, R. J. Coleman, and L. M. Lawrence, *University of Kentucky, Lexington.*

Forage is an important part of any horse feeding program and accordingly, it is important to be able to accurately predict the amount of forage a horse will consume. A review of the literature was undertaken to determine if a relationship exists between forage chemical composition and voluntary dry matter intake (VDMI) in mature horses.

Six studies representing VDMI of 21 different forages (4 alfalfa and 17 grass hays) were used. Grass hays included both cool and warm season varieties. The only forage chemical components that were consistently reported across all studies were CP and NDF. Because of this, the relationships of CP to VDMI and NDF to VDMI were examined. The CP content of the grass hays ranged from 8.0 to 17.5% while the legume hays ranged from 14.8 to 20.9%. The NDF content of the grass hays ranged from 59.5 to 74.9% while the legume hays ranged from 40.9 to 56.3%. All studies used mature horses that were allowed ad libitum access to long hay. Only studies that reported animal weights specific to each trial and measured intake over a minimum of 4 d were used. All reported VDMI values were converted to g/kgBW/d.

Crude protein was not strongly related to VDMI (R²=.14, grass hays; R²=.34, grass and legume hays combined). The relationship of NDF to VDMI for grass hays alone is expressed by the equation y=124.55+.0155x²-2.5742x (R²=.67) where x=%NDF and y=g/kgBW/d VDMI. The relationship for grass and legume hays combined is expressed by the equation y=18.377-.0051x²+.3895x (R²=.53). No equation was calculated for alfalfa hays alone because only four VDMI values were available. The lower correlation between NDF and VDMI when both grass and legume hays were analyzed may be related to differences in the structure and digestibility of grasses and legumes. The data reviewed from these papers suggest that, when compared to CP, NDF values will provide a better prediction of the dry matter intake of mature horses fed long stem hay.

Key Words: Horse, NDF, Intake

482 Effects of residual and reapplied biosolids on forage and soil mineral concentrations in North Florida. M.E. Tiffany, L.R. McDowell^{*}, G.A. O'Connor, H. Nguyen, F.G. Martin, and N.S. Wilkinson, *University of Florida, Gainesville.*

Effects of single applications and residual effects of exceptional quality biosolids to bahiagrass (*Paspalum notatum*) pastures were studied from June to November in relation to beef cattle nutrient requirements. Thirty .8 ha pastures were assigned one of 11 treatments representing three sources of biosolids. Three biosolids (Baltimore, Tampa and Granulite) were applied at an "agronomic rate" (X) and 2X. Four of the treatments represented residual applications of the Baltimore and Tampa biosolids which had been applied to pastures as in the previous year. The control plot received NH₄NO₃. The highest Granulite treatment was higher (P<0.05) than the control in P and K at many

sampling times. Both Tampa reapplied treatments resulted in forage Ca higher than the control. Forage crude protein (CP) concentrations were high and met beef cattle requirements for all treatments, with Granulite treated forages consistently higher ($P < 0.05$) than the control. Forage receiving Tampa treatments had improved ($P < 0.05$) Zn concentrations over the control at most samplings, times, with this increase often seen in the Tampa residuals as well. Forage Mo concentrations were minute, and though some treatment effects were observed ($P < 0.05$), there was no threat of toxic accumulations observed at any time. Many biosolids treated pastures contained excess S, ($> .40\%$) and were greater ($P > 0.05$) than controls. All forage Cu levels were less than the requirement of 10 ppm, low Cu plus high S ($> .40\%$) increases the likelihood of Cu deficiency. In relation to grazing beef cattle requirements, all treatments resulted in generally adequate forage levels of Ca, P, Mg, K, and CP, however, Na, Co, Cu, Se and Zn concentrations were deficient.

Key Words: Biosolids, Forage, Minerals

483 The interrelationship of solar radiation and leaf area on growth of *Pennisetum purpureum* cv Mott. T. Clavero*¹, ¹La Universidad del Zulia.

The effects of fertilization on leaf area index, light interception, growth rate and the relationship between these parameters on dwarf elephantgrass (*Pennisetum purpureum* cv Mott) were evaluated. The study included four levels of nitrogen (0, 60, 120 and 180 kg N/ha). Treatments were replicated three times in a randomized block design. Plots were irrigated as necessary to maintain active growth. Dwarf elephantgrass growth for each season exhibited significant differences ($P < 0.05$) in mean live yield, leaf area index and light interception. Maximum live yield obtained during the rainy season was about 14.2 TN/ha. Critical leaf area index was approximately 8.0 - 8.4. Maximum mean growth rate for this season was about 315 kg/ha/day. During the dry season, dwarf elephantgrass attained a maximum live yield of about 10.5 TN/ha. Critical leaf area index was most likely around 5 - 5.5 with a maximum mean growth rate of about 250 kg/ha/day. This research showed significant differences between season growth. The results suggest that dwarf elephantgrass showed high growth rate due to high radiation and long days during the rainy season.

Key Words: *Pennisetum purpureum* cv Mott, leaf area index, growth rate

484 Effects of fertilization on biomass production of *Clitoria ternatea*. T. Clavero*¹, ¹La Universidad del Zulia.

A field experiment under tropical dry forest conditions was carried out in a dryland farming area in Venezuela in order to evaluate the biomass production of *Clitoria ternatea* under three levels of N (0, 100, 200 kg/ha) and three levels of P (0, 150, 300 kg/ha). A split-plot in randomized block design with four replications was used. Results obtained show that the N*P interaction affected ($P < 0.05$) the total biomass and composition of forage (stem and leaves production). Total dry matter yield of *C. ternatea* increased linearly with increasing N and P rate. The highest value for total biomass was 1.2 TN/ha when the legume was fertilized with 200 kg N/ha and 300 kg P/ha. Leaves and stem production ranged from 260 to 580 and 170 to 480 kg/ha respectively and were higher with a fertilizer of 200 kg N/ha and 150 kg P/ha. Dead material was not affected by fertilization which showed mean values of 0.18 and 0.12 TN/ha for heavy N*P doses (200-300 kg/ha) and lower N*P doses (0-0 kg/ha), respectively. It is concluded that fertilizer N and P benefits biomass production on *Clitoria ternatea*.

Key Words: *Clitoria ternatea*, biomass production, Fertilization levels

485 Effect of intensity and harvest frequency on dry matter yield of *Acacia mangium* Willd. A. Rodriguez-Petit¹, T. Clavero*², and R. Razz², ¹Centro de Transferencia de Tecnología en Pastos y Forrajes, ²La Universidad del Zulia.

A field experiment was carried out in Zulia State, Venezuela. The objectives were to evaluate the total dry matter yield (RMST) and its components (fine fraction, RMSFF and gross fraction, RMSFF); and also the growth rates (TCT, TCFF and TCFG) of *Acacia mangium* Willd under three intervals of cutting (42, 63 and 84 days) and three cutting heights (50, 75 and 100 cm). A randomized block design with treatments in split plot arrangement was used. The results showed that total dry matter yield and growth rate was affected by harvesting interval. The

maximum values were: 735.03, 588.31 and 146.75 g/plant for RMST, RMSFF and RMSFG, respectively, when the plants were harvested at 84 days. The same tendency was observed for growth rates (2.92, 2.33 and 0.58 g/plant/day for TCT, TCFF and TCFG, respectively). RMST and RMSFG was affected by the combined action of harvesting interval and cutting height. Maximum values was obtained with 84 day cutting intervals and 100 cm of height. *Acacia mangium* Willd shows highest yields with the least frequent and least severe defoliation.

Key Words: *Acacia mangium*, dry matter yield, growth rates

486 *Flourensia cernua* extracts decrease intake of alfalfa pellets by sheep. R. E. Estell*¹, M. R. Tellez², E. L. Fredrickson¹, D. M. Anderson¹, K. M. Havstad¹, and M. D. Remmenga³, ¹USDA/ARS Jornada Experimental Range, Las Cruces, NM, ²USDA/ARS Natural Product Research Center, University, MS, ³New Mexico State University, Las Cruces.

Our objective was to evaluate the effects of three extracts (hexane, ether, and ethanol) isolated from tarbush (*Flourensia cernua*) on intake of alfalfa pellets by sheep. In each of two experiments, 45 ewe lambs received one of five treatments for 5 d (randomized complete block, three lambs on each treatment per block). Treatments were alfalfa pellets (CON) or alfalfa pellets plus ethanol carrier (CAR), hexane extract (HEX), ether extract (ETH), or ethanol extract (ETOH). Treatments were isolated from tarbush leaves (36 kg) using a sequential extraction of hexane, diethyl ether, and 100% ethanol. Extractions (3 kg of leaves in 7 L of solvent, constant mixing, 22 h per solvent) were filtered, solvents removed using a rotary evaporator, and resuspended in ethanol. Lambs were offered 640 g of alfalfa pellets (DM basis) and intake was monitored during a 20-min interval each morning. Extracts were applied to alfalfa pellets at the same concentration as in tarbush in Exp. 1, and at 10-fold dilutions in Exp. 2. Lambs were adapted to handling and individual pen feeding for 10 d and maintained and fed alfalfa pellets (4.7% of BW, DM basis) as one group except during 20-min tests. All three extracts reduced intake by lambs in Exp. 1 ($P < .0001$) compared to CON or CAR. Mean intake during the 20-min period was 361, 393, 204, 212, and 228 g for CON, CAR, HEX, ETH, and ETOH, respectively (SEM = 28.9). Intake did not differ between CON and CAR, nor among HEX, ETH, and ETOH. Mean intake in Exp. 2 was not different (468, 455, 389, 381, and 431 g for CON, CAR, HEX, ETH, and ETOH, respectively; SEM = 30.5; $P = .187$). Three fractions containing mixtures of compounds of increasing polarity were equally effective in decreasing intake of alfalfa pellets at concentrations encountered in intact tarbush plants; thus, several compounds are probably involved in the low palatability and differential use of this shrub typically exhibited by livestock.

Key Words: Intake, Plant Extracts, Sheep

487 Introduction and cultivation of 5 grass varieties in Qinba mountain area. J. Luo*, S. H. Cao, X. F. Zhao, Q. Liu, and H. Y. Yang, Goat Research Institute of Northwest Agricultural University, Yangling, Shaanxi, China.

A study was conducted to compare the growth performance and nutritional values of 5 grass varieties which were introduced and cultivated in Qinba mountain area in south Shaanxi province in China and to select the most suitable varieties in the region. The 5 varieties, including *Medicago sativa* L., *Trifolium repens* L., *Bromus catharticus* vahl, *Lolium perenne* L., and *Amaranthus paniculatus* L. were chosen according to the specific climatic conditions of Qinba mountain area, and the characteristics of phenology, heat resistance, growth and development and nutritional value were recorded during the growth period. All grasses were planted in spring on the 10 m² plot with two replicates for each grass. The results indicated that the introduced spring planting grass germinated uniformly and grew fast in the early growth period because of appropriate temperature, in the hot and dry summer time, all forages grew slowly but demonstrated a good adaptability, drought and heat resistance. The wilting coverage score of 5 forages were between 3 to 4 points (5 point scoring system, 1 point means wilting grass percentage is greater than 80%; 5 point, less than 20%), and the white clover had the best resistance to heat and drought. The fresh forage yield of *Medicago sativa* L. and *Trifolium repens* L. was 20,000 and 34,000 kg/ha, respectively. In conclusion, all introduced forages were well adapted to the summer climatic conditions of Qinba mountain area, showing strong

drought and hot resistance, fast growth and high utilization values, and should be widely extended in Qinba mountain area of Shaanxi province.

Key Words: Grass, Introduction, Qinba mountain area

488 *Tripholium pratense*: Degradability and intestinal digestibility. M. de J. Marichal^{*1}, M. Carriquiry, A.I. Trujillo, and L. Astigarraga, ¹ *Facultad de Agronomía, Universidad de la República.*

Rumen nitrogen (N) and non-nitrogen organic matter (NNOM) dynamics and N intestinal digestibility (ID) were estimated to characterize and identify changes in nutrient availability of red clover spring forage. Forage was harvested in early (Sep 1, Oct 9) and late Spring (Nov 3, Dec 26). Degradability (*In sacco*) and ID (Mobile bag technique) were estimated in 3 Holstein dry cows fed alfalfa hay. Data were analyzed as a completely random design. Potentially degradable fractions (PDF) and degradation rates (kd) were compared by confidence intervals, and soluble fractions (SF) and ID by t-test. Effective degradability was estimated as $a + (bc/c+k)$, $a = SF(\text{zero-time})$, $b = PDF$, $k = \text{outflow rate, } 6\%/h$, and $c = kd$. PDF and kd originated from $a + b(1 - e^{-kt})$, $t = \text{time}$. Forage fermentable NNOM (FNNOM) and rumen degradable protein (RDP) appeared to be higher in early than in late Spring. Differences in rumen dynamics within each period and fraction were registered, with carbohydrates varying more than proteins. Cell wall and protein contents and characteristics, would explain these results. Differences in N digestibility may result from changes in protein fractionation (i.e. ADIN/NDIN-ADIN) associated with variation in forage morphological composition and phenological stage (PS). Results suggest fermentable carbohydrates would limit microbial protein synthesis. Consumed as only feed, forage RDP would exceed animal requirements and that UDP intake may meet animal requirements.

Harvest date	Sept	Oct	Nov	Dec
Chemical composition, %DM				
NNOM	58.7	55.7	69.7	61.7
NDF	24.7	27.8	39.8	37.9
ADF	17.4	17.2	26.9	29.2
ADL	5.9	5.8	6.2	8.3
CP				
NDIN	2.22	2.52	1.32	1.10
ADIN	0.36	0.36	0.35	0.39
PS	V	V	PB	PB-B
Plant height, cm	24	16	52	24
Leaf/Stem	2.1	5.1	1.1	0.8
Degradability				
NNOM, %				
SF	23a	13c	16b	15b
PDF	65e	79d	23f	58e
kd ¹	9e	8e	15d	4f
FNNOM	55.4	52.5	28.9	32.7
N, %				
SF	41c	41c	44b	54a
PDF	55d	57d	34e	35e
kd ¹	8e	8e	16d	2f
RDP	23	25	14	13
ID, %	48b	66a	68a	46b

a,b,c:P<0.05; d,e,f:γ =0.95; V=vegetative,PB=pre-bloom;B=bloom; 1=%/h

Key Words: red clover, degradability, intestinal digestibility

489 Agronomic and nutritional evaluation of commercial corn hybrids in Brazil. A.H. Fonseca, M.N. Pereira*, R.G. Von Pinho, and R.G.S. Bruno, *Federal University of Lavras, Lavras, Brazil.*

Corn is a major crop for the dairy industry in Southeastern Brazil. Our objective was to obtain environmentally specific data on the available hybrids and possibly establish genetic agronomic goals. Three replicates of 60 commercial hybrids were cultivated during the 1997/1998 rainy season. Plants were harvested at half milk line and ensiled in mini-silos. Agronomic variables considered were: Production of DM per hectare (PDM), plant DM content, plant and ears height, ears as a percentage of plant DM, stay green score, kernel texture, plant

population, prolificity, lodging, and incidence of *Phaeosphaeria maydis*. Silages CP, NDF, ADF, EE, ash and Klason lignin were chemically analyzed and 5 mm dried-ground samples incubated *in situ* at once in 10 non-lactating cows for 0, 12, 24 and 96 hours. Effective ruminal DM degradation (EFET) was calculated as the sum of the assumed instantaneously degradable DM fraction plus the slowly degradable DM times $[kd/(kd+kp)]$, kp at 0.04/h. NDF was 54.5 3.9 (mean SD), range:44.6-66.5% of DM. EFET was 54.3 2.5, range:47.6-58.5% of DM. PDM was 16.1 2.1, range:10.0-21.3 tons/hectare. Plant height was 2.45 0.20, range:1.94-2.97 m. Stepwise methodology was used for selecting agronomic and nutritional variables best predicting EFET. The best models containing one, two, three and four variables included: NDF ($R^2=0.54$), ADF and NDF ($R^2=0.57$), ADF, NDF, and stay green score ($R^2=0.61$), ADF, NDF, plant height, and stay green score ($R^2=0.64$). High fiber concentration, tall plants, and slow dry down were related to low EFET. Correlations between plant height and DMP and NDF were 0.46 and 0.35, respectively ($P<0.01$). The correlation between PDM and NDF was 0.04 ($P=0.73$). There is potential to improve nutritional quality without lowering production per area. Genetic goals should attempt to lower fiber content and decrease plant height, aiming at greater digestibility values.

Key Words: Corn silage, Digestibility, Agronomy

490 Effect of dietary sugarcane concentration on heifer growth. P.C.S. Gallo, M.N. Pereira*, and M.A.F. Andrade, *Federal University of Lavras, Lavras, MG/Brazil.*

Sugarcane is a viable alternative for raising Holstein heifers. However, an average daily gain of 1 kg was obtained when concentrate-feed intake was 1.1% of BW. This trial was an attempt to establish how low on concentrate a sugarcane-based diet could go and still provide adequate growth. Twenty-seven Holstein heifers (265.5 36.4 kg of initial BW) received one of three diets for 8 weeks, following a 2-week standardization period. Dietary sugarcane NDF concentration (54.2% NDF on a DM feed basis) was (% of DM): 33.4 (diet 33), 37.9 (diet 38), and 42.3 (diet 42). Crude protein was 16% of diet DM in all treatments. Protein sources were soybean meal, corn gluten meal and 11 grams of urea per kg of diet DM. Data obtained weekly was analyzed by repeated measures (SAS Mixed Model Procedure). The model included a covariate term (CV), which was a measurement of the same variable done during the last day of the standardization period. Increasing sugarcane concentration from 62 to 78% of diet DM, stimulated rumination plus eating time per kg of DMI, but tended to reduce intake. No differences were detected on heifer growth within this dietary sugarcane concentration range. ±

Trait	33	38	42	SEM	P for		Quad-ratic
					diet	Linear	
DM intake, kg/d	7.4	6.8	6.6	.3	.17	.07	.62
Body weight, kg	298	298	295	2.7	.26	.15	.43
Daily gain, g/d	1002	979	951	50	.94	.74	.98
Height at withers, m	1.19	1.20	1.20	.01	.30	.52	.18
Chew time, min/d	662	730	723	44	.50	.34	.49
Chew time, min/kg DMI	100	119	130	7.2	.03	.01	.63

Key Words: Sugarcane, Heifer, Chewing time

491 Feed resources and dairy animal productivity in Gangetic Plains of India. S. P. Singh*, C.S. Azad *University of Agriculture & Technology, Kanpur, India.*

The Gangetic Plains is a vast area that comprises the State of Punjab, Haryana, U.P. Bihar and Bengal rice-wheat is the predominant cropping system of this region. Buffalo is the main dairy animal followed by cattle of the region. Since rice, wheat and sugarcane are the main crops of this area, therefore, the animal population mainly depends upon their by-products, i.e., straws and sugarcane tops. These crop residues are characterized by high lignin & fiber content and low protein and mineral content. The animals consuming these feeds may suffer from

malnutrition, hence, their production and reproduction is often low. In the present study an attempt is made to divide this region in different zones, according to feed resources, and animal productivity and strategies to improve animal performance and milk yield of each zone.

492 Influence of pasture sward height and concentrate supplementation on intake, digestibility and grazing time of lactating beef cows. O. J. Gekara*, E. C. Prigge, W. B. Bryan, and E. L. Nestor, *West Virginia University, Morgantown.*

To establish the effect of sward height (SH) and concentrate supplementation on performance of grazing cattle, twenty-four crossbred Angus beef cows (535 kg BW) and calves (114 kg BW) were grouped by weight and calving date. They were randomly assigned to two SH treatments, either 4-8 cm or 8-12 cm, and fed three levels of supplement: high (H), low (L) or none (U) consisting of 6.24, 3.12 and 0 kg/head/day, respectively. The experiment was repeated over three 15 d periods in 1996: May (P1), June/July (P2) and August (P3). No SH x supplement level x period or SH x supplement level interaction ($P > .10$) were evident for responses tested. Cows on lower SH had greater ($P < .08$) DMI but spent an additional 1.3 hr/d ($P < .01$) grazing compared to cows on higher SH. Sward height had no influence ($P > .10$) on forage DMD and ADG of cows. Forage DMI, DMD and grazing time (GT) decreased ($P < .05$) as supplementation increased but ADG was not affected ($P > .10$). Nonetheless, supplemented cows consumed more total DM ($P < .08$) than non-supplemented cows. Cows consumed 2.4 kg/d more forage DM ($P < .01$) in P1 than in P2 and P3. Grazing efficiency (DMI/hr GT) declined as supplementation increased and grazing season advanced ($P < .01$). Cows gained 2.6, 0.2 and 0.8 kg/d ($P < .05$) and calves gained 1.4, 1.2 and 1.6 kg/d ($P < .10$) during P1, P2 and P3, respectively. Decreased forage DMI and grazing efficiency with supplementation suggests that supplemented cattle can optimally graze at SH lower than non-supplemented cattle.

Key Words: Pasture, Sward Height, Supplementation, Cattle, Intake, Digestibility, Grazing Time

493 Degradability of nitrogen in overseeded oat, wheat, and rye forages harvested on five dates in the spring. W. K. Coblenz*, K. P. Coffey, J. E. Turner, D. A. Scarborough, J. S. Weyers, K. F. Harrison, L. B. Daniels, C. F. Rosenkrans, D. W. Kellogg, and D. S. Hubbell, *University of Arkansas, Fayetteville.*

A study was conducted in northern Arkansas to evaluate the characteristics of N degradation for three cereal-grain forages (wheat, oat, and rye) harvested on five dates (March 24, April 15, May 4, May 26, and June 5) throughout the spring of 1998. Digestion kinetics of N were evaluated by the in situ procedure. Four (454-kg) ruminally cannulated crossbred steers were offered a basal diet consisting of alfalfa hay (50%) and concentrate (50%) to create a nutrient mixture similar to that consumed by a lactating dairy cow. For all cereal forages, the potential extent of N degradation declined ($P < .05$) with advancing harvest date and the associated advancement of plant maturity. The potential extent of N degradation was very high on the March 24 harvest date ($> 95\%$), but declined ($P < .05$) to $< 80\%$ in oat and wheat forage by the June 5 harvest date. The potential extent of N degradation for rye forage declined ($P < .05$) to $< 60\%$ on the May 4 and June 5 harvest dates. Rates of N degradation were very fast ($> 0.16/h$) initially; however, nonsignificant ($P > .05$) declines were observed for wheat and oat forages that reached a minimum (0.085 and 0.109/h, respectively) on the May 4 harvest date. Rates of N degradation increased sharply ($P < .05$) thereafter for both species to a maximum of 0.287/h for oat and 0.476/h for wheat. In contrast, decay rates for rye increased ($P < .05$) with harvest date to a maximum of 0.614/h. The rapid rates of N degradation at advanced growth stages are likely associated with grain fill. For all forages, the effective degradability of N declined ($P < .05$) with harvest date through May 4, but increased ($P < .05$) thereafter in association with grain fill. The degradation kinetics of N for cereal-grain forages are profoundly affected by the complex, concurrent processes of elongation and lignification of stem tissue and grain fill.

Key Words: nitrogen, degradation kinetics, in situ

494 Influence of supplemental protein degradability on nutrient utilization by beef cows on dormant, cool-season forage. M. Palmer* and K.C. Olson, *Utah State University, Logan.*

Multiparous crossbred beef cows ($n=25$, BW=611 kg) were randomly assigned to 5 treatment groups of 5 cows each using a completely randomized design to evaluate supplemental DIP:UIP effects on intake, forage utilization, and cow performance. The cows were group-fed tall fescue straw (NDF 73%, CP 5.9%) ad libitum and individually supplemented daily with blends of 2 soybean meal sources varying in ruminal degradability. The treatment supplements contained 28%, 34%, 40%, 45%, and 51% UIP. Two sampling periods were conducted: late gestation and early lactation. Total and forage DM intake as a percentage of body weight had a treatment by physiological stage interaction ($P < .01$). Total and Forage DM intake decreased with increasing UIP% during both gestation and lactation with the exception of 28% UIP in gestation and 51% UIP in lactation (cubic, $P \leq .02$). Dry matter digestibility did not differ among treatments, with an LSM \pm SE of $43.5 \pm 0.94\%$. Neutral detergent fiber digestibility decreased linearly ($P = 0.10$) as UIP % increased. Blood urea nitrogen displayed a treatment by physiological stage interaction ($P = 0.06$). It varied cubically ($P = 0.08$) during gestation and had no response during lactation. Calf weight at end of supplementation, at weaning, and adjusted 205-day weight did not differ ($P > .10$) among treatments, with overall LSM \pm SE of 95.7 ± 2.6 kg, 235.5 ± 4.9 kg, 249.6 ± 5.6 kg, respectively. However, calf ADG tended to increase linearly ($P = 0.11$) as cow supplemental UIP % increased. Milk production had a quadratic response to supplemental UIP %, with the highest level at 45% UIP. Cow weight loss, BCS loss and PPI were not affected by supplemental UIP% with LSM \pm SE of -2.421 ± 0.089 kg, -0.300 ± 0.048 , 46.2 ± 2.4 d, respectively. Because milk production and calf ADG were higher and forage intake lower at higher UIP %, increasing UIP % appeared to improve feed conversion to calf growth. However, increasing UIP % depressed forage utilization by the cow, with minimal effect on cow performance.

Key Words: Beef Cattle, Protein Degradability, Low Quality Forage

495 Effect of supplemental energy source and degradable intake protein amount on performance of spring-calving cows winter grazing stockpiled bermudagrass. C.R. Johnson*, D.L. Lalman, A.D. O'Neil, and J. Steele, *Oklahoma State University, Stillwater.*

Sixty-three mature spring-calving beef cows were used in a completely randomized design to determine the effects of energy source and DIP level on cow performance while grazing stockpiled bermudagrass pastures. Twenty-eight and thirty-five cows were allocated to one of four supplement regimes, at each of two locations (STW and HASK). A negative control (NEG) was imposed and supplement groups were either 1) soyhull based (SH); 2) corn-based with similar DIP to SH (LC); or 3) corn-based with double the DIP of SH. The SH and LC supplements were formulated to provide 63 g/d DIP and the HC supplement supplied 125 g/d of DIP. Pastures were grazed to approximately 7.5 cm in late August and fertilized with 56 kg N/ha. Grazing was deferred until November 15, upon which treatments were initiated and continued for 70 days. Methods for collecting forage samples for determination of nutritive value varied by location. At STW, masticate samples were collected using esophageally cannulated steers, at HASK, forage pluck samples were collected. Average forage CP (DM basis) during the trial was $17.2 \bar{n} .71\%$ at STW and $8.6 \bar{n} .87\%$ at HASK. Forage NDF (DM basis) averaged $52.7 \bar{n} 1.84\%$ at STW at $69.9 \bar{n} 2.14\%$ at HASK. Upon initiation of the trial all treatment groups and locations were similar ($P > .5$) in weight (WT; $547 \bar{n} 13.7$ kg) and body condition (BCS; $5.1 \bar{n} .11$). However, more forage was accumulated at HASK ($3253 \bar{n} 199$ kg DM/ha; $P < .0001$) compared to STW ($1588 \bar{n} 226$ kg DM/ha). Cow BCS change was unaffected by treatment ($P > .1$) and location ($P > .5$). Cow WT change was unaffected by treatment ($P > .2$), yet cows at STW gained $11.9 \bar{n} 3.7$ kg more ($P < .001$) than HASK. Due to the lack of change in body condition, mean weight gain ($73.5 \bar{n} 4.3$ kg) is attributed to change in fetal mass. This study demonstrates that during mild winters, supplemental energy and DIP is not required for maintaining body condition of spring-calving beef cows grazing stockpiled bermudagrass pastures.

Key Words: Stockpiled forage, Supplementation, Spring-calving cows

496 Performance of stocker cattle grazing bermudagrass and winter annuals under rotational or continuous stocking. K.A. Cassida*, C.B. Stewart, S.A. Gunter, and P.A. Beck, *University of Arkansas, Hope.*

We initiated a long-term evaluation of pasture management systems using stocker calves grazing common bermudagrass-dallisgrass overseeded with wheat-annual ryegrass-clover. Pasture treatments are a factorial arrangement of 2 grazing systems (C, continuous stocking; R, 6-paddock rotation) and 3 stocking rates (SR)(1998-3.7, 6.2, 8.6 animals/ha; 1999-4.9, 7.4, 9.9 animals/ha). Limousin-cross heifers grazed from May 18 to October 7, 1998, and Angus-cross steers and heifers grazed from Feb. 16 to Aug. 18, 1999. Calves received 0.45 kg/d of a corn-based mineral supplement and were fed hay if pasture availability was limiting. In 1998, animals performed similarly on C and R pastures. There was a linear effect of stocking rate on ADG (.57, .39, .35 kg/d, $P < .01$, for 3.7, 6.2, 8.6 head/ha, respectively) and gain/ha (300, 332, 426 kg/ha, $P < .05$). Hay feeding was not required in 1998. In 1999, type of forage influenced results. On winter annuals, ADG (.64, 1.01 kg/d) and gain (544, 831 kg/ha) were lower for C than R pastures ($P < .05$) at the highest SR and were similar at lower SR. In the transition period between winter annuals and bermudagrass, ADG (.64, .43 kd/d) and gain (270, 188 kg/ha) was higher on C than R pastures ($P < .01$) across SR. On bermudagrass, ADG and gain was similar for C and R. On winter annuals, ADG decreased linearly as SR increased. For transition and bermudagrass periods, gain/ha increased with SR, but ADG was similar across SR. In 1999, C pasture calves used more hay than R pasture calves at the two higher SR (0, 108, 142 and 0, 0, 30 kg DM/animal/year as SR increased, $P < .10$). Response of calves to R or C grazing systems depended on forage type and stocking rate.

Key Words: Stocker Cattle, Grazing Systems, Stocking Rate

497 Effects of Calendar Date and Summer Management on In Situ Nitrogen Degradation of Stockpiled Bermuda. D. A. Scarbrough*, W. K. Coblenz, K. P. Coffey, J. E. Turner, G. V. Davis, and D. W. Kellogg, *University of Arkansas, Fayetteville.*

Limited information is available concerning N utilization of dormant bermudagrass [*Cynodon dactylon* L. Pers.] by ruminant animals throughout winter. 'Greenfield' bermuda was stockpiled at two sites following either hay or pasture summer management; annual N fertilization rates were 345 and 215 kg N ha⁻¹ at the hay and pasture sites, respectively. Beginning on October 17, 1997, forage samples were taken from each site at four-week intervals under caged enclosures until January 9, 1998. The effects of calendar date and summer management on the kinetics of in situ N degradation were evaluated using five ruminally cannulated, cross-bred steers (mean BW = 387 \pm 18 kg). At the hay site, rates of N degradation did not differ ($P > .05$) on October 17 or January 9 (.056 h⁻¹) but were higher ($P < .05$) on November 14 (.064 h⁻¹). Potential extent of N degradation decreased ($P < .05$) between October 17 (747 g kg⁻¹ N) and January 9 (578 g kg⁻¹ N). Effective ruminal N degradability did not change ($P > .05$) between October 17 and November 14 or between December 12 and January 9, but decreased sharply ($P < .05$) from November 14 to December 12 (602 g kg⁻¹ N vs. 539 g kg⁻¹ N). At the pasture site, rates of N degradation were lowest on October 17 (.044 h⁻¹), but increased ($P < .05$) to .080 h⁻¹ on January 9. Potential extent of N degradation decreased ($P < .05$) from 790 g kg⁻¹ N on October 17 to 682 g kg⁻¹ N on January 9. Effective N degradability did not change ($P > .05$) over the first three sampling dates (590 g kg⁻¹ N) but was highest ($P < .05$) on January 9 (624 g kg⁻¹ N). The unusually high degradation rate (.080 h⁻¹) and effective degradability (624 g kg⁻¹ N) at the pasture site on the January 9 harvest date were likely due to the presence of winter annual weeds that were not present at the hay site. These data suggest that rumen availability of N in stockpiled bermuda decreases as winter progresses.

Key Words: Stockpiled Bermudagrass, In Situ, N Degradation

498 Dynamics of changes of feeding value and feed intake by sheep of two ryegrass species during primary spring growth. A. Ombabi, K.-H. Suedekum*, and F. Taube, *University of Kiel, Germany.*

This study evaluated the effects of maturity related alterations in the chemical composition of two grasses during primary growth on nutrient

digestibilities and feed intake by sheep. Pure swards of perennial ryegrass (*Lolium perenne* L., variety Gremie) and Italian ryegrass (*Lolium multiflorum* Lam., variety Lema) were harvested daily between April 23 and June 19 during primary spring growth 1991 and each grass was offered to a group of five sheep for *ad libitum* intake. A continuous digestion trial design was employed to measure daily intakes and fecal outputs of organic matter (OM) and OM constituents. The chemical composition of the grasses varied considerably with growth. Crude protein concentrations declined from 17.4 to 5.2% of dry matter (DM) for perennial ryegrass and from 15.6 to 3.7% of DM for Italian ryegrass, whereas concentrations of some cell-wall fractions markedly increased and partly more than doubled. Fiber content was slightly greater for perennial ryegrass than for Italian ryegrass over the whole growth period. The decline of feeding value with maturity was closely related to increasing concentrations of fiber components and their digestibility. Intake by sheep of Italian ryegrass was higher by 3 g/kg of body weight at the beginning and at the end of the primary growth period. Digestibility of the OM was greater than 80% at the start of the experiment and still around 70% after two months of grass growth. The decline in DM and metabolizable energy intake was much more pronounced than the decrease of OM digestibility, which could be due to a decline in feed intake capacity of non-lactating sheep caused by increasing body fat mass. Short-term fluctuations in OM digestibilities were related to alterations of chemical composition of the grasses caused by growth and maturation, in particular variations in water-soluble carbohydrate concentrations. Continuous digestion trials were effective in observing the dynamics of alterations in feeding value and feed intake by sheep as related to growth and maturation of two ryegrass species during primary spring growth.

Key Words: Grass, Digestibility, Intake

499 Effects of protein and energy supplements on changes in weight and body condition of gestating beef cows grazing bahiagrass during the fall. P. A. Davis*¹ and W. E. Kunkle¹, ¹*University of Florida, Gainesville.*

Protein and energy supplements for gestating beef cows grazing bahiagrass pastures were evaluated for effects on body condition score (BCS), ultrasound fat thickness over the rib and rump and shrunk weight (BW). Sixty Angus beef cows (435 kg initial average BW) were stratified by initial BCS (range from 4.2 to 5.8, 1 to 9 system) and randomly assigned to twenty predominantly bahiagrass pastures. Five supplementation treatments were arranged in a two by two factorial design plus an unsupplemented control (C) with four pastures assigned to each treatment. Supplement treatments were protein ([P], 33% CP, 68% TDN mostly from cottonseed meal) or energy ([E], 14% CP, 69% TDN, mostly soybean hulls and wheat middlings) with or without 150 mg/d monensin (M) added. Supplements were cubed (1.9 cm), P and P+M were fed on three days each week at .45 kg/d equivalent rate, and E and E+M were fed daily at 2.7 kg/d. Cattle were offered a vitamin-mineral mixture *ad libitum* and had adequate forage in all pastures during the 84 d trial started on September 21, 1999. Cows gained BW (.84 kg/d) during the 84 d trial and protein supplementation did not ($P > .2$) affect gain (.80 for P vs. .75 kg/d for C), BCS change (+.21 for P vs. -.01 for C), or ultrasound fat thickness change (+2.52 for P vs. +2.60 mm for C). Cows fed E tended ($P = .15$) to gain more than C (.94 for E vs. .75 kg/d for C), but differences were not found in BCS change (+.19 for E vs. -.01 for C), or ultrasound fat thickness change (+3.68 for E vs. +2.60 mm for C). Cows fed supplements with M had similar ($P > .10$) gains (.89 for M vs. .85 kg/d for C), BCS change and ultrasound fat thickness change compared to C. Cows with one unit lower initial BCS had .16 kg/d higher gains ($P = .039$) for the 84 d trial. Forage quality was excellent as evidenced by weight gains and increases in ultrasound fat during the trial and supplementation had little effect on performance.

Key Words: Body Condition Score, Protein, Energy

500 Effects of bypass sulfur amino acids on performance of growing cattle fed bermudagrass hay supplemented with molasses-based supplements. L. B. Davis*¹, W. E. Kunkle¹, D. B. Bates¹, and B. A. Reiling¹, ¹*University of Florida, Gainesville.*

This research investigated whether performance responses to protein supplements could be explained by total sulfur amino acids (TSAA, methionine plus cystine) in bypass (UIP) protein. Supplements were

formulated to provide 2, 4, or 6 g/d of TSAA in UIP from either corn gluten meal (CGM) or a rumen protected methionine (MEP, MEPRON M 85). These were compared to a molasses-corn (control) supplement. Supplements contained 84% fortified (urea, minerals, vitamins) sugar-cane molasses and 18% corn. CGM replaced corn in supplements containing CGM. Fourteen pens (5 head/pen) of crossbred steers and 14 pens of crossbred heifers were assigned within sex to the 7 treatments in 1998-99. Calves averaged 230 kg and body condition score averaged 5.2 at the start of the experiment (December 1, 1998). Bermudagrass hay was offered ad libitum and molasses slurries were limit fed at 2.2 kg DM/d (fed twice each week) during the 113-d trial. Animal data were averaged for each pen which was the experimental unit. Cattle gains increased linearly ($P = .004$) for increasing bypass TSAA supplied by CGM (23 gm increase in gain for each gm/d bypass TSAA) but cattle gains were similar at all levels of MEP (.66, .72, .64, .71 kg/d for 0, 2, 4, 6 gm/d bypass TSAA from MEP). Supplemental TSAA did not affect height change, body condition score change, or DM intake. Gain/feed was improved .0034 units (linear, $P < .018$) for each gram of bypass TSAA supplied by CGM but was similar for all levels of MEP. Cattle fed CGM supplements had increased BUN (9.9 to 13.2 mg/dl) as the bypass TSAA level and supplemental nitrogen intake increased, but cattle fed increasing TSAA levels from MEP had similar BUN (10.3 mg/dl) and similar supplemental N intake. Steers compared to heifers had .07 kg/d higher ($P = .0002$) gains, .44 kg/d higher ($P = .002$) dry matter intakes, similar gain/feed ($P = .23$), and .11 units (1 to 9 system) lower ($P = .08$) body condition score change. This research showed that supplemental CGM improved performance but that MEP did not improve performance. In contrast, previous research indicated that bypass TSAA from feed (CGM or blood-feather meal) or a different synthetic source had similar improvements in gain and gain/feed for growing cattle fed similar diets. Reasons for differing results were not apparent.

Key Words: Supplementation, Methionine, Molasses

501 Digestibility and ruminal parameters of endophyte-infected fescue at four stages of maturity in wethers. S. J. Paton*, B. T. Larson, D. L. Harmon, N. D. Paton, C. J. Richards, and K. C. Swanson, *University of Kentucky, Lexington.*

Eight ruminally and duodenally-fistulated Lincoln wethers (38.5 kg) were used in a 4 x 8 Latin rectangle to evaluate the influence of four maturities of endophyte-infected tall fescue on digestibility and ruminal parameters. Maturities of fescue included mid-season vegetative regrowth (V), boot (B), mature (M), and stockpiled (S). Intake of fescue was 2.25% BW (except M at 1.5% BW) in two portions at 0700 and 1900. Adaptation (d 1 to d 7) was followed by Co:EDTA dosing and subsequent ruminal fluid sampling (d 8 at 0800, 1100, 1400, 1700, and 2000; d 9 at 0200 and 0800), total fecal and urine collection (d 8 to d 11), duodenal samples (d 12 to d 14 every 6 h advancing two h/d), and ruminal fluid sampling (d 14 at 1000, 1300, 1600, and 1900) for pH, ammonia, and VFA analyses. Total tract apparent digestibility of DM, NDF, ADF, and CP and apparent ruminal digestibility of DM, NDF, and ADF was highest ($P < .05$) for B, intermediate for V and lowest for M and S. Apparent ruminal digestibility of CP was highest ($P < .05$) for V and B, intermediate for M and lowest for S. Ruminal liquid dilution rate (%/h) was not different between treatments ($P > .05$). Total VFA (mM) was greatest ($P < .05$) for B; V and S were greater ($P < .05$) than M. Ruminal pH was lower ($P < .05$) for B and S (6.4 and 6.5) than V and M (6.6). Molar percentages of propionate were higher ($P < .05$) for B and S (20.2, 18.3) compared to V and M (16.3, 14.5). Acetate was lower ($P < .05$) for M (44.9) than V, B and S (58.1, 61.1, and 56.5). Acetate:propionate ratio was higher ($P < .05$) for V (3.6) than B, M and S (3.2). Ruminal ammonia concentrations (mM) were greatest ($P < .05$) for V and B (9.4, 8.9) intermediate for M (7.8) and lowest for S (4.5). Maturity of endophyte-infected tall fescue has a significant effect on digestibility and ruminal parameters in wethers with vegetative and boot stages having overall better digestive effects than mature or stockpiled.

Key Words: fescue, maturity, rumen

502 Effect of stocking rate and season on performance of steers grazing endophyte infested tall fescue. M.A. Marsalis*, J.C. Waller, and H.A. Fribourg, *University of Tennessee, Knoxville TN/USA.*

Tall fescue (*Festuca arundinacea*) is one of the predominant and most important cool-season forages in Tennessee and the Mid-south U.S. Most tall fescue is infested with the endophytic fungus *Neotyphodium coenophialum*. This endophyte-tall fescue combination benefits the host plant but causes reduced performance, conception rates, intolerance to heat and reduced prolactin in cattle grazing the infected (E+) plant. This condition in cattle is known as tall fescue toxicosis. Annual production losses are estimated to be more than \$1 billion in the U.S. and over 100 million in Tennessee. A 4-year study was conducted to evaluate steer performance on pastures with different E+ levels ranging from <5 to >80 percent and three stocking densities (low, medium and high). Eighteen 1.2-ha pastures were grazed with a total of 96 newly weaned Angus and Angus Cross steers with initial weights of about 250 kg. Animal and available forage weights were measured at 21-d intervals. In each year, three grazing seasons from early November to March (fall-winter), March to July (spring) and July to early September (summer) were used. Average daily gain (ADG) and beef production (kg ha⁻¹) for each season were different ($P < .05$) and were 335 g d⁻¹ and 100.8 kg ha⁻¹ for fall-winter, 480 g d⁻¹ and 155 kg ha⁻¹ for spring, and 260 g d⁻¹ and 38 kg ha⁻¹ for summer respectively. Seasonal ADG for fall-winter, spring and summer were 475 g d⁻¹, 556 g d⁻¹, 297 g d⁻¹; 286 g d⁻¹, 496 g d⁻¹, 317 g d⁻¹; 242 g d⁻¹, 389 g d⁻¹, 166 g d⁻¹; for low, medium and high stocking densities, respectively. Results show that season and stocking density had a significant effect on ADG and beef production when steers grazed E+ tall fescue.

Key Words: Tall Fescue, Steer Performance, Endophyte

503 The relationship between digestibility and steer daily gain in tall fescue and birdsfoot trefoil pastures. L. Wen*, J. E. Williams, R. L. Kallenbach, C. Roberts, R. L. McGraw, P. R. Beuselinck, J. F. Thompson, L. Gebrehiwot, H. Benedict, and E. Navarro, *University of Missouri, Columbia.*

A grazing study and in situ experiment were conducted to compare the relationship between chemical components, forage digestibility, and steer performance. The experiment treatments consisted of tall fescue (TF) and TF + birdsfoot trefoil with (RBFT) and without (BFT) rhizomes in a continuous grazing system. The experimental pastures were established in 97 in a randomized complete plot design with 4 replicates (0.53 hectare) per treatment. In summer (May, 11-July, 1) and fall (Sep. 22-Nov. 17) 98 grazing season, steers were weighed every 14 days, while forage samples were collected from each plot every 28 days; they were freeze-dried and ground through 2mm screen. An in situ study was carried out in May, 99 with two ruminally cannulated heifers grazing TF + RBFT and BFT mixed pasture. Samples of dried forage were incubated for 0, 3, 6, 12 and 24 h to determine DM disappearance (DMD) and rate of DM degradation. The ADG for those grazing TF+BFT, TF+RBFT pastures (.92, .93 kg/d) were greater ($P \leq .05$) than that of TF (.64 kg/d) in summer; no differences ($P \geq .05$) existed in ADG of steers among the pastures in the fall. The ADG was correlated to 24-h DMD ($r = .55$, $P \leq .01$). The 24-h DMD was correlated to NDF ($r = -.89$, $P \leq .01$), to ADF ($r = -.96$, $P \leq .01$), to CP ($r = .67$, $P \leq .01$). In summer, NDF was 74.7, 72.7, 69.5% for TF, RBFT+TF and BFT+TF, respectively; CP was 9.1, 11.2, 12.5%, correspondingly. The 24-h DMD for BFT+TF and RBFT+TF (39.8, 40.5%, respectively) was greater ($P \leq .01$) than that of TF (36.7%). Throughout summer, DMD for each treatment decreased ($P \leq .01$) every 28 days. In fall, NDF was 69.1, 64.9, 63.0% for TF, RBFT+TF and BFT+TF, respectively; while CP was 10.9, 13.1, 14.9%, correspondingly. For the fall, the 24-h DMD for RBFT+TF (47.1%) and BFT+TF (46.6%) was greater ($P \leq .01$) than that of TF (37.8%). Interseeding birdsfoot trefoil in tall fescue pastures increased ADG and DMD in the summer, while differences in DM disappearance among pure TF and mixed pastures did not contribute to differences in ADG among treatments in the fall.

Key Words: ADG, DM disappearance, birdsfoot trefoil

504 Influence of corn silage fiber content and level of dietary concentrate supplementation on intake, digestion, and milk production by dairy cows. H. Al-Jobeile, M. A. Bal, R. D. Shaver*, and J. G. Lauer, *University of Wisconsin, Madison.*

Twenty-four multiparous Holstein cows (8 fitted with rumen cannulae) averaging 75 DIM at trial initiation were used in a replicated 4 x 4 Latin square design with 28 d periods. Treatments were low-NDF (LFCS; Cargill 3677) and high-NDF (HFCS; Garst 8751) corn silage each fed at two levels of dietary concentrate supplementation. Diets (DM basis) contained 53% forage and 47% concentrate with 19-21% NDF from forage at the high level of concentrate supplementation (HCD) and 61-67% forage and 33-39% concentrate with 24% NDF from forage at the low level of concentrate supplementation (LCD). The forage mixture was comprised of 67% treatment corn silage and 33% alfalfa silage (DM basis). Diets were formulated to contain 18% CP (DM basis) using corn-soybean meal based concentrates and were fed as TMR once daily. The corn silage treatments were harvested at one-third (HFCS) to one-half (LFCS) milkline stage of maturity using a crop-processing harvester set at 1.27 cm TLC and 2 mm roll clearance and stored in separate silo bags. The DM, NDF, and ADF contents (DM basis) of LFCS and HFCS corn silage treatments were 34.2%, 32.8%, and 18.9% and 36.7%, 39.2%, and 22.7%, respectively. Intakes of DM (27.2 vs. 26.7 kg/d) and NDF (7.7 vs. 7.0 kg/d) were higher ($P < 0.05$) for HFCS than LFCS diets. There was no effect of hybrid on milk yield or composition. Milk (44.9 vs. 42.5 kg/d) and FCM (41.1 vs. 39.9 kg/d) yields were higher ($P < 0.05$) for HCD than LCD. Milk fat content was lower (3.46 vs. 3.61%) but CP content was higher (3.14 vs. 3.06%) for HCD than LCD ($P < 0.05$). Total-tract NDF digestibility was higher (38.5 vs. 31.9%) and starch digestibility was lower (97.8 vs. 98.5%) for HFCS than LFCS diets ($P < 0.05$). Higher NDF digestibility for HFCS appeared to offset benefits of LFCS on lactation performance. Feeding diets containing 19-21% NDF from forage increased DMI, milk yield, and milk component yields over diets containing 24% NDF from forage.

Key Words: Corn Silage, Milk Production, Digestion

505 The effects of feeding processed or non-processed corn silage to lactating cows on dry matter intake, milk production, and milk components. C. M. Luhman*, *Land O'Lakes, Inc. and Cooperative Research Farms, Webster City, IA.*

Sixteen multiparous Holstein cows (average 65 DIM) were used in a replicated 4 X 4 Latin Square experiment. All treatments were based on corn silage variety and processing. Two treatments used were Croplan variety 534 that was harvested unprocessed and Croplan variety 534 with the chopped whole corn plant processed through a kernel processor before ensiling. Experimental periods were 21 days. The first seven days were used for transition to the new treatment and data was collected for the last 14 days of the period. Silages were allowed to ensile for at least 30 days before the bags were opened and the trial was started. Data was analyzed by using standard ANOVA procedures of SAS for replicated Latin Squares. In situ dry matter and starch digestibility was higher for processed corn silage than for non-processed corn silage. In this trial, cows fed processed corn silage produced enough additional milk to increase income \$0.54/cow/day over control fed cows when increased DMI was included (assumes milk price of \$12 cwt).

	Croplan 534	Processed Croplan 534	P=
DMI, kg/d	23.4	25.0	0.04
Milk, kg/d	40.7	44.4	0.10
FCM, kg/d	38.4	42.3	0.08
SCM, kg/d	35.7	39.3	0.08
Milk fat, %	3.23	3.26	-
Milk fat, kg/d	1.3	1.44	0.07
Milk protein, %	2.88	2.91	-
Milk protein, kg/d	1.17	1.29	0.08
Milk total solids, %	11.53	11.64	-
Milk total solids, kg/d	4.68	5.14	0.07

506 The effects of feeding potato leafhopper resistant or non-resistant alfalfa hay to lactating dairy cows. C. M. Luhman*, *Land O'Lakes, Inc. and Cooperative Research Farms, Webster City, IA.*

Thirty-one multiparous Holstein cows (average 110 DIM) were assigned to one of two treatments in a randomized complete block design. Treatments were a lactating cow ration containing a non-potato leafhopper resistant alfalfa variety (n=16) and an equivalent ration containing a potato leafhopper resistant alfalfa variety (n=15). Ration forage was an equal mix (DM basis) of corn silage and alfalfa hay. Hays were second cutting of first year spring sewn alfalfa. Hays were baled and then chopped immediately before inclusion into a TMR containing primarily corn and soy products. Trial length was 10 wk. Data was analyzed using the repeated measures option of GLM in SAS. Differences in milk production were highest when milk production was highest, i.e. weeks 1, 2, 3, 4, and 5 of trial ($P \leq 0.10$). Body weights and body condition scores of cows fed the two varieties were not different. Potato leafhopper resistant alfalfa hay apparently increased return 30.1 cents/cow/d at milk prices of \$12 cwt, especially at higher milk production (wk 1-5 of trial).

	Non-resistant	Resistant	P=
N	16	15	
Milk, kg/d	36.2	38.1	0.11
DM intake, kg/d	24.1	24.9	0.44
Milk fat, %	3.72	3.51	0.70
Milk protein, %	3.11	3.00	0.55

507 Effect of storage method, length of fermentation and days of aerobic exposure on dry matter consumption of native tropical grasses ensiled in large round bales in a tropical environment. G. Gonzalez¹, A.A. Rodriguez*¹, R. Macchiavelli², and E.O. Riquelme², ¹*Department of Animal Science, ²Department of Agronomy and Solis, University of Puerto Rico, Mayaguez Campus.*

An experiment was conducted to evaluate the effect of storage method, length of fermentation, and days of aerobic exposure on the voluntary dry matter intake of native tropical grasses (NTG) ensiled in large round bales (LRB; 350kg). Native tropical grasses (*Panicum maximum* and *Johnson halapense*; 37% DM %) were harvested at the Lajas Agricultural Experiment Station, University of Puerto Rico. The forage was ensiled in 12 LRB and was assigned to two treatments; storage with direct sunlight exposure (T1) and storage under shade area (T2). Three bales for each treatment were opened after two fermentation periods, 53 d (LF 1) and 111 d (LF 2), and were exposed to aerobic conditions for 4 days. Feed intake was determined for each treatment at each length of fermentation and day of aerobic exposure using six Holstein Friesian heifers (200 kg) assigned in pairs to three pens. Each pen was provided with double feeders. Water was offered at each pen ad libitum. The silage offered was weighed and given daily at 8:00 am, and the rejected material was weight after 24 hours. Forage preference (acceptability) was determined using the equation $\text{TrtI}/\text{TI} * 100$, where TrtI = treatment intake, TI = total intake ($\text{IT1} + \text{IT2}$). The voluntary intake was expressed as percentage of the offered material. Data were analyzed using a split plot over time model. The results indicate that storage method or length of fermentation did not affect ($p > 0.05$) the voluntary dry matter intake of NTG ensiled in LRB. However, for both treatments and length of fermentation, silage dry matter consumption decreased as length of aerobic exposure increased. In summary, under tropical environments storing NTG ensiled in LRB under roof did not improve the dry matter consumption of Holstein heifers, regardless of length of fermentation.

Key Words: Large round bales, Storage method, Silage intake

508 Effects of sampling site and silo type on fermentation and amino acid content of hay crop silages. M. J. Stevenson*¹, R. A. Patton², S. P. Crosby³, and J. Zmich³, ¹*Degussa-Huls Canada, Burlington, Ontario, Canada, ²Nittany Dairy Nutrition, Mifflinburg, PA, ³Fingerlakes Nutrition Service Inc., Genoa, NY.*

Previous work had demonstrated that degradation of lysine could occur during the ensiling of grasses and legumes. Because accurate prediction of lysine content in silages is critical for accurate prediction of flow to the intestine, it is important to quantify lysine content rapidly and economically. In order to investigate which parameters might be associated

with lower lysine content, 41 different haylages were obtained from 30 dairy farms from Ontario and central and western New York. Samples of each feed were obtained from the feeding surface and at a depth of approximately 0.6m. Factors investigated were sampling site and silo type. CP was numerically, but not significantly, lower for deep samples (20.2 vs 19.7%). Individual amino acids (% of CP) were not different between surface and deep samples although total amino acids were greater for interior samples (58.6 vs 56.7% CP, $P < .05$). Type of silo produced differences as below. Variables (%DM) with different superscripts differ significantly ($P < .05$).

There was no statistical difference in amino acid content between actual and that predicted with Degussa-Huls regression equations except for lysine and arginine which were predicted at higher levels ($P < .05$). Lysine was moderately correlated with pH ($R^2 = -.42$), propionic acid ($R^2 = -.52$), isobutyric acid ($R^2 = -.46$) and NH_3 ($R^2 = .54$). Arginine was correlated only with propionic acid ($R^2 = -.47$). It is of interest to note that silages with low values of lysine and arginine were identified, subjectively on farm by odor, as of poor quality. There was no significant correlation between butyric acid and either lysine or arginine.

Variable	Bunker	Tower	Oxygen Limiting
Titrateable acid	4.59 ^a	3.74 ^a	2.67 ^b
Lactic acid	5.01 ^a	4.53 ^a	3.02 ^b
Acetic acid	2.39 ^a	1.12 ^b	0.97 ^b
Propionic acid	0.24 ^a	0.02 ^b	0.02 ^b
Total VFA	8.54 ^a	5.72 ^b	4.03 ^c
Free NH_3	2.72 ^a	1.18 ^b	1.21 ^b
NDF-protein	3.23 ^a	2.81 ^a	3.97 ^b

Key Words: amino acids, haylages, silo types

509 Prediction of amino acid composition of grass silage and corn silage using near infrared spectroscopy (NIR). M.L. Swift^{*1}, J.A. Shelford¹, and L.M. Rode², ¹Faculty of Agricultural Science, University of British Columbia, Vancouver, Canada., ²Agriculture & Agri-Food Canada, Lethbridge, Alberta, Canada.

Samples of grass (102) and corn (102) silage were collected from the lower Fraser Valley region of British Columbia. Grass silage (GS) samples represented 4 crop years, 3 species (orchard grass, perennial rye, tall fescue), 5 cuts, 4 preservative treatments (none, acid, bacterial, enzyme) and 3 storage methods (bunker, sealed upright silo, Ag-Bag). The CP content of the GS samples ranged from 7.9% to 25%. Samples of corn silage (CS) represented 3 crop years, 6 varieties, 3 preservative treatments (none, acid, bacterial) and 3 storage methods (bunker, sealed upright silo, Ag-Bag). The CP content of the CS samples ranged between 6.9% and 11.9%. Amino acid composition (%DM) of GS was HIS 0.155(0.048-0.312), ARG 0.742(0.272-1.451), THR 0.412(0.085-0.87), VAL 0.59(0.251-0.993), MET 0.10(0.022-0.242), ILE 0.419 (0.171-0.685), LEU 0.745(0.287-1.39), PHE 0.472(0.167-0.94), LYS 0.341(0.098-0.707). Amino acid composition (%DM) of CS was HIS 0.0105(0.055-0.166), ARG 0.32(0.17-0.754), THR 0.243(0.101-0.383), VAL 0.322(0.242-0.514), MET 0.055(0.012-0.155), ILE 0.235(0.166-0.39), LEU 0.579(0.336-0.944), PHE 0.272(0.163-0.428), LYS 0.155(0.071-0.324). Subjecting spectral data to 60 different mathematical treatments developed preliminary equations. Resulting co-efficient of variation (RSQ) and standard error of cross validation (SECV) for amino acids in GS were HIS 0.77,0.03; ARG 0.83,0.16; THR 0.86, 0.08; VAL 0.83,0.09; MET 0.54,0.04; ILE 0.85,0.05; LEU 0.83,0.11; PHE 0.80,0.08; and LYS 0.67,0.10. RSQ and SECV for CS were HIS 0.80,0.01; ARG 0.86,0.05; THR 0.64,0.03; VAL 0.53,0.03; MET 0.33,0.02; ILE 0.50,0.03; LEU 0.77,0.06; PHE 0.74,0.03; LYS 0.64,0.03. Work is ongoing to develop equations based on the positive results from these preliminary equations.

Key Words: Amino acid, Forage, NIR

510 Performance of dairy cows fed corn silage differing in kernel texture or sugarcane as the dietary forage. C.E.S. Correa, M.N. Pereira^{*}, M.H. Ramos, S.G. Oliveira, and M. Ota, Federal University of Lavras, Lavras, MG/Brazil.

Kernels from a dented corn cultivar had greater ruminal *in situ* degradation and less decrease in digestibility with advanced maturity than flint corn. A flint cultivar (P 3041) was ensiled at half milk line stage and a dented cultivar (AG 4051) at black layer stage. Dry matter and

NDF content were 31.7 and 42.9% for flint corn silage (FCS), and 41.7 and 44.0%, for dented corn silage (DCS), respectively. Three primiparous and 6 multiparous Holsteins (616 kg) were fed FCS, DCS or finely ground fresh sugarcane (SCA, 33.0% DM and 43.2% NDF) in a triplicated 3x3 Latin Square design with 21-day periods. Dietary forage NDF content was 19.9, 20.1 and 19.6% of dry matter for treatments FCS, DCS, and SCA, respectively. The two non-orthogonal contrasts were: 1)(FCS+DCS) vs SCA. 2)FCS vs DCS. Sugarcane lowered intake and yield and had no effect on chewing activity. Sugarcane may be a viable forage alternative for lactating Holsteins in which nutrient demand is not at a maximum. Dented corn ensiled at a later stage of growth than the flint cultivar did not decrease performance when silage was at 45% of diet dry matter.

Trait	FCS	DCS	SCA	SEM	P for forage		
					1	2	
Dry matter intake,kg/d	23.2	23.0	21.5	.6	.13	.05	.82
Milk yield, kg/d	34.6	34.2	31.9	.4	<.001	<.001	.82
Fat yield, kg/d	1.22	1.20	1.16	.02	.13	.06	.46
Fat %	3.57	3.54	3.64	.06	.44	.22	.73
Protein yield, kg/d	1.08	1.06	1.02	.02	.11	.05	.41
Protein %	3.13	3.10	3.22	.04	.06	.02	.61
Chewing time, min/d	710	704	687	23	.77	.49	.87
Chewing time, min/kg DMI	30.1	32.1	33.6	1.5	.29	.19	.37
Rumen pH (rumenocentesis)	6.02	6.01	6.08	.12	.92	.69	.96

Key Words: Corn silage, Sugarcane, Kernel texture

511 Effects of addition of *Acremonium* cellulase on tissue structure and ruminal digestion of alfalfa and timothy silages. K. Ataku^{*1}, A. Aniwaru¹, T. Watanabe¹, H. Terui¹, and L. Chase², ¹Rakuno Gakuen University, Hokkaido, Japan, ²Cornell University, Ithaca, NY.

The objective of this study was to characterize the effects of the addition of *Acremonium* cellulase on the tissue structure of both timothy and alfalfa silages. A scanning electron microscope (S-EM) was used to measure changes in structure of parenchyma tissue. Timothy *Phelum pratense* and alfalfa *Medicago sativa* forages were cut into 2-cm lengths and placed in nylon bags. Additives applied were lactic acid bacteria *Lactobacillus casei* at 8 ppm(LC), *Acremonium* cellulase at 0.01%(AC), both LC and AC(LC+AC) and formic acid at 0.3% for timothy and 0.5% for alfalfa(FA). Control forages were also ensiled. The additives were sprayed onto the forage, mixed and ensiled in 1-liter silos for 50 days. Each silo contained 8 replicate bags. At the end of the ensiling period, 4 bags from each silo were frozen for S-EM analysis. The other bags were used for a 48-hour *in situ* digestion, removed and frozen for S-EM analysis. Fresh, nonfermented (INRT) samples were also analyzed. Disappearance of the inner parenchyma tissue was observed in the control,LC,AC and LC+AC treatments for both silages. No changes in parenchyma tissue were observed in the FA samples. Samples from the *in situ* digestion had a decrease in inner parenchyma tissues in the INRT,LC,AC,LC+AC and FA treatments for the alfalfa silage. There was no apparent change in the inner parenchyma tissue in both control silages.

Key Words: Alfalfa silage, Timothy silage, Parenchyma tissue

512 Efficacy of cellulase/xylanase enzymes in a direct-fed application for dairy cows. T. R. Dhiman^{*1}, R. R. Gimenez¹, I. S. MacQueen¹, J. L. Walters¹, and R. Treacher², ¹Utah State University, Logan, ²Finnfeeds International Ltd. Wiltshire, UK.

A study was conducted to determine the yield response of dairy cows to cellulase and xylanase enzymes applied to the forage prior to feeding the diets. Fifty cows at the end of week 6 in lactation were blocked according to milk yield and randomly assigned to five treatments. Cows were fed a control diet during wk 7, 8, and 9 of lactation (pre-treatment). Starting week 10, cows were fed a control diet (CTL), or control diet

with enzyme 4011 applied to the forage at a rate of 1.30 L/ton of dry forage (E4011); or enzyme 4011 (1.30 L/ton of dry forage) plus enzyme X at the rate of 0.002 L/ton of dry forage (E4011+EXL); or enzyme X at a rate of 0.002 L/ton of dry forage (EXL); or enzyme X at 0.030 L/ton of dry forage mix (EXH). The required amount of enzyme was diluted with water to bring the volume to 10 liters/ton of fresh forage mix. Clean water was added in CTL. The diet contained 46% forage and 54% grain. The forage portion of the diet had 50% alfalfa hay and 50% corn silage on DM basis. Enzyme treated TMR was offered to the cows within 30 minutes after mixing. The experiment lasted until cows completed week 21 of lactation. Daily feed intake and milk yield were recorded. Once a week, milk samples were analyzed for composition. Feed intakes were 27.1^{ab}, 27.5^{ab}, 25.7^b, 26.3^b, and 28.9^a kg/d in CTL, E4011, E4011+EXL, EXL, and EXH treatments, respectively. Feeding enzyme treated feed did not alter the feed intake of cows. However, higher dose of enzyme X (EXH) increased the feed intake of cows compared with low dose (EXL). Fat-corrected milk yield was 39.0, 39.5, 40.6, 39.0 and 40.4 kg/d in CTL, E4011, E4011+EXL, EXL, and EXH treatments, respectively. Milk yield was not affected by enzyme treatment. Milk fat content, protein content and milk produced per kg feed intake were not different among treatments. Results suggest that treating the forage portion of the diet with cellulase/xylanase enzymes prior to feeding did not influence the performance of cows in this study.

Key Words: Forage, Cow, Milk

513 Effects of Stage of Maturity at Harvest and Kernel Processing on the Nutritive Value of Corn Silage Diets. T. J. Wistuba*, L. A. Whitlock, M. K. Siefers, R. V. Pope, and K. K. Bolsen, *Kansas State University, Manhattan.*

The nutritive value of the six whole-plant corn silage diets was determined using 12 ruminally cannulated, yearling steers in a Latin square metabolism study. All diets contained 90% silage and 10% supplement on a dry basis. The 180d periods consisted of a 10-d diet adaptation and an 8-d total fecal collection. The six silages were: 50% milklime, 80% milklime, and 7-d after-black layer (7BL), each was ensiled processed (Roskamp® roller mill) or unprocessed. The corn was grown under irrigation and the forage was chopped to a 10 mm particle length; and the DM content was 32, 38, and 42% for the 50 and 80% milklime and 7BL silages, respectively. Dry matter intake was not affected ($P>.05$) by either stage of maturity or processing. The only significant ($P<.05$) stage of maturity by processing interaction was for CP digestibility. Processing increased ($P<.01$) starch digestibility (95.9 vs. 93.9%), but it also decreased ($P<.05$) CP (74.6 vs. 76.4%) and NDF (51.6 vs. 53.5%) digestibilities. Steers fed the 7BL silage diets had the lowest ($P<.05$) DM, OM, starch, and ADF digestibilities.

Key Words: silage, kernel processing, stage of maturity

514 The effect of sample physical form on in situ digestion kinetics. K.J. Harvatine*, P.J. Kononoff, and A.J. Heinrichs, *The Pennsylvania State University, University Park.*

In situ techniques are commonly employed to study ruminal degradation of feed. It has been suggested that feed physical form regulates the rate and extent of rumen degradation. Typically samples are ground through small screens resulting in particles much smaller than those normally found in the rumen. The objective of this experiment was to develop an in situ method that best simulates digestion kinetics in vivo and could subsequently be used in experiments studying the effects of forage particle size. A composite sample of a haylage based TMR was prepared in two different forms. In first method, material was dried at 50°C then ground through a Wiley Mill fitted with a 1-mm screen. For the second method rumen digesta particle size was determined using a wet sieving process. Fresh material was then chopped using a food processor resulting in a sample composed of similar shaped particles as found in the rumen. Six rumen cannulated cows arranged in a completely randomized design were used to compare the effects of sample physical form on digestion kinetics. Samples of approximately 5 mg/cm² were placed into nylon bags of two different sizes. Dried and ground material was placed in 10 X 20 cm bags, conversely fresh and chopped was placed in 30 X 36 cm bags. Cows were fed a haylage based TMR and bags of both methods were incubated in replicate for 0, 1, 2, 4, 8, 12, 16, 24, 36 and 48 h in the rumen of each animal. Results indicated that OM of dried and ground samples had a significantly ($P<0.05$) higher soluble fraction (37.6 % vs. 35.4 %), degradation rate (11.3 %/h vs. 8.1

%/h), and calculated effective ruminal degradability (65.4 % vs. 62.3 %). Matching sample physical properties to naturally occurring characteristics resulted in different digestion kinetics than conventionally prepared samples.

Key Words: In situ technique, particle size

515 Reed canarygrass management for dry cow forage. J.H. Cherney*, D.J.R. Cherney, and E. Mikhailova, *Cornell University, Ithaca, NY.*

Potassium (K) concentration of perennial grasses has been reported from as low as .1% K up to as high as 7.0% K. Potassium content of grass is critical when considering dry cow diets. Our objective was to evaluate the K content and forage quality of reed canarygrass managed for dry cow forage production. Reed canarygrass was established in 1992 and again in 1993 at two Ithaca sites. At these sites in 1995 and 1996, respectively, a two-harvest per season management was initiated in early June and late September and continued through 1999, with three rates of N fertilizer and three rates of K fertilizer. Crude protein averaged 16% for the spring harvest and 12% for the fall harvest at the high N fertilization rate in 1999. In vitro true digestibility declined with increased N fertilization, but remained above 70%. Neutral detergent fiber digestibility also declined with increased N fertilization, dropping to 62% in the spring and 50% in the fall at the high N fertilization rate. Neutral detergent fiber (NDF) increased from 61 to 65% with increased N fertilization in the spring and did not differ across N fertilization rates in the fall of 1999, averaging 58%. Withholding K fertilization reduced the available soil K to low levels in less than two years, resulting in minimized K uptake and very low forage K concentrations. With 112 kg actual N fertilizer per ha applied at spring greenup and after spring harvest in June, 1999, forage K content averaged 1.1% in June-harvested forage and .6% in September-harvested forage. Dry matter yields were influenced by year and N fertilization. In a droughty year, 1999, yields were 1,779, 4,000 and 6,522 kg DM per ha for N fertilizer rates of 0, 112 and 224 kg N fertilizer per ha, respectively. In a year with adequate moisture, 1998, yields were 4,356, 9,236, and 11,509 kg DM per ha for N fertilizer rates of 0, 112, and 224 kg N fertilizer per ha, respectively.

Key Words: Mineral, Hypocalcemia, Grass

516 Ruminal fermentation and in situ degradation of grazing dairy cows supplemented with full-fat roasted soybean or sunflower meal. F. Piñeiro*, D. Rearte, F. Santini, and F. Bargo, *Fac. Cs. Agr. UNMdP-EEA INTA Balcarce. Argentina.*

Four ruminally cannulated Holstein cows were used in a replicated 2 x 2 Latin Square with 21 d-periods to study the effect of feed full-fat roasted soybeans (RS) or sunflower meal (SM) supplementation on ruminal fermentation and in situ CP and NDF degradation of pasture and protein sources. Treatments were 2.2 kg DM/d of RS or SM. RS and SM had 32.6 and 35.8%CP, 23.5 and 38.3%Soluble CP/total CP, 23.0 and 3.4%EE, 71.6 and 71.1%in vitro DM digestibility (IVDMD), respectively. Cows grazed during 13-wk an annual winter pasture (*Lolium multiflorum* L., *Avena sativa*L.) during the day and a perennial pasture (*Lolium perenne* L., *Dactylis glomerata* L, *Trifolium repens* L.) during the night with in average 1140 kg DM/ha herbage mass, 19.7 %CP, 33.5 %NDF and 75.1 %IVDMD. Both treatments received 4.8 kg DM/d of dry ground corn, 4 kg DM/d of corn silage (59.1 %IVDMD). Neither pH (RS: 5.96 vs. SM: 5.97) nor NH₃-N concentration (RS: 19.2 vs. SM: 19.0 mg/dl) in ruminal fluid were affected by treatments ($P>0.05$). Rate of degradation and effective degradability (ED) of CP were lower ($P<0.05$) for RS. Protein sources did not affect ($P>0.05$) CP degradation fractions of pasture, which had a high ED of CP (average 75.6%). RS tended ($P<0.10$) to increase lag time and decreased ($P<0.05$) ED of NDF of pasture. RS may be used as a low rumen degradable protein source to supplement cows on pasture but because of high content of polyunsaturated oil may affect ruminal NDF degradation of pasture.

	RS	SM	SEM	P<
Concentrate				
Soluble CP, %	4.2	17.8	3.40	0.10
Degradable CP, %	92.2	77.8	3.80	0.11
Rate, %/h	5.0	16.0	1.36	0.02
ED of CP ¹ , %	14.6	72.1	1.20	0.0001
Pasture				
Soluble CP, %	51.4	54.5	2.97	0.55
Degradable CP, %	41.7	38.7	3.05	0.63
Rate, %/h	7.2	8.5	0.47	0.19
ED of CP ¹ , %	73.9	77.3	0.88	0.11
Soluble NDF, %	30.9	36.9	1.29	0.08
Degradable NDF, %	49.1	45.4	1.97	0.31
Rate, %/h	10.1	9.6	0.50	0.26
Lag time, h	4.5	1.2	0.78	0.09
ED of NDF ¹ , %	50.7	60.4	1.02	0.02

¹rate of passage assumed: 6%/h

Key Words: roasted soybean, pasture supplementation, in situ degradation

517 Effect of full-fat roasted soybean supplementation on performance of grazing dairy cows. F. Piñeiro*, D. Rearte, F. Santini, and F. Bargo, *Fac. Cs. Agr. UNMDP-EEA INTA Balcarce, Argentina.*

Thirty-two Holstein cows (33 DIM, 580 kg BW, 4 primiparous) were used in a randomized complete block design to study the effect of replacement sunflower meal (SM) by full-fat roasted soybeans (RS) as protein supplement on milk production and composition, DMI, plasma metabolites, and BCS and BW change. Treatments were: 1. SM-based concentrate (SM-C), and 2. RS-based concentrate (RS-C). Cows received 7 kg/d of a 70 % ground corn and 30 % protein source concentrate. SM-C and RS-C had 16.8 and 15.8 % CP, 4.0 and 10.2 % EE, 82.4 and 82.6 % in vitro DM digestibility (IVDMD), respectively. Cows grazed during 13-wk an annual winter pasture (*Lolium multiflorum* L., *Avena sativa* L.) during the day and a perennial pasture (*Lolium perenne* L., *Dactylis glomerata* L., *Trifolium repens* L.) during the night with in average 1140 kg DM/ha herbage mass, 19.7 %CP, 33.5 %NDF and 75.1 %IVDMD. Both treatments received 4 kg DM/d of corn silage (55.5 %NDF, 59.1 % IVDMD). DMI, estimated in six cows per treatment using Cr₂O₃ as fecal marker, was not affected by treatments ($P > 0.05$). Milk yield and protein content tended ($P < 0.11$) to decrease and protein yield was lower ($P < 0.05$) in RS-C. Fat content and yield were similar ($P > 0.05$) between treatments. Plasma urea nitrogen (PUN) and glucose did not differ between treatments ($P > 0.05$). BW and BCS change were not different between treatments ($P > 0.05$). RS supplementation to dairy cows at pasture did not improve performance, probably because the high polyunsaturated oil content in RS affect fiber digestibility of forage, which represented 70 % of the total diet.

	SM-C	RS-C	SEM	P<
Total DMI, kg/d	20.80	21.47	1.98	0.82
Concentrate DMI, kg/d	6.95	6.95	0.09	0.99
Forage DMI, kg/d	13.85	14.52	1.95	0.82
Milk, kg/d	23.96	22.97	0.41	0.08
Fat, %	3.47	3.61	0.06	0.14
Fat, kg/d	0.83	0.81	0.02	0.64
Protein, %	3.29	3.24	0.02	0.11
Protein, kg/d	0.78	0.73	0.01	0.005
PUN, mg/dl	12.95	14.87	0.86	0.12
Glucose, mg/dl	64.02	65.13	1.34	0.55
BW change, kg	-3.00	1.00	7.69	0.71
BCS change	-0.25	-0.14	0.10	0.42

Key Words: roasted soybean, dairy cows, pasture supplementation

518 Modifications of the purine assay to increase accuracy and precision. K.W. Creighton*, R.A. Mass, and T.J. Klopfenstein, ¹University of Nebraska, Lincoln.

Due to poor repeatability in current purine assays, three experiments were conducted to investigate the combination of different modifications of the assay in an attempt to increase accuracy and precision. In Trial 1, ten brome and alfalfa omasal samples were used to evaluate the effect

of acid stringency on purine recovery. Hydrolysis was conducted with either 12 M or 2 M HClO₄ at 95°C for 1 h. Purine recovery with 2 M acid was higher (14.86 vs. 4.46 mg/g, $P < .001$) and more precise (3.14 vs. 14.87% CV, $P < .005$), suggesting that 2 M acid was more favorable. In Trial 2, buffer type and wash solution were investigated, using 2 M HClO₄ for hydrolysis. Buffers were .2 M ammonium phosphate (PO₄) solution or a .2 M acetic acid (AA) solution. During the wash procedure, a solution of .005 N H₂SO₄ plus .005 AgNO₃ (SN) or the initial precipitation solution (buffer+HClO₄+AgNO₃; PREC) was used. There was no interaction between buffer solution and wash solution for mean purine values; both PO₄ buffer (6.07 vs. 1.65 mg/g; $P < .0001$) and PREC (4.32 vs. 3.40 mg/g; $P < .003$) increased mean purine recovery. An interaction existed ($P < .02$) for CV values, as PO₄/PREC (2.84%) produced the lowest CV (most precise), with AA/SN (12.61%) having the worst precision and AA/PREC (6.87%) and PO₄/SN (9.85%) being intermediate. We conclude that for total purine recovery, a milder hydrolysis followed by precipitation in PO₄ buffer and washing with the original precipitation buffer yields the highest accuracy and precision. In Trial 3, the new procedure was used to determine microbial purine (P) to microbial N (N) ratios on NDF residues of five forages from in situ incubations. Bags were incubated for 12 h, washed, and residues were analyzed for microbial N (total N-NDIN) and purine. Values ranged from .28 for higher quality forages (alfalfa, brome, and high quality meadow hay) to .36 and .41 for low quality meadow hay and switch grass, respectively. These results imply that forage type has an effect on purine to total microbial N ratios and is a means of determining P:N ratio.

Key Words: Purines, Microbial protein, Ruminants

519 Evaluation of internal markers from fescue hay. E. S. Vanzant*, D. W. Bohnert, K. B. Combs, B. T. Larson, and D. L. Harmon, *University of Kentucky, Lexington.*

Four Angus steers (avg body weight = 440 kg) were fed a 100% fescue hay diet (15% CP; 77% NDF; 43% ADF; 4.8% ADL) at 95% of ad libitum intake. Markers evaluated included acid-insoluble ash (AIA), acid detergent lignin (ADL), and indigestible acid detergent fiber (IADF) analyzed by each of five procedures. All IADF procedures included acid/pepsin pretreatment of forage samples. For standard IADF (STD), samples were incubated in vitro individually for 144 h, extracted in acid detergent solution, and filtered through coarse Gooch crucibles. The other 4 procedures were arranged as a 2 x 2 factorial: batch incubation of samples for 168 h, either intraruminally (IS), or in an Ankom batch in vitro incubator (IV), in either standard in situ-type bags (Ankom # 1020) cut to 5.0 x 5.5 cm and heat sealed, or fiber filtration bags (Ankom #F-57, 5.0 x 5.5 cm), followed by batch acid detergent extraction. Fecal marker recoveries differed ($P < .10$) for all pairwise comparisons among AIA, ADL, and STD IADF (90.4, 110.5, and 100.1%, respectively). IADF concentrations of hay and fecal samples were affected by a sample type x treatment interaction ($P < .01$); differences between techniques were greater with fecal than with hay samples, although ranking of the techniques was similar between sample types. Average IADF concentrations for hay samples were 17.4, 10.4, 14.8, 13.4, and 16.7% and, for fecal samples, 37.4, 23.5, 34.3, 27.9, and 34.6% for STD, IS/1020, IS/F57, IV/1020, and IV/F57, respectively. For fecal samples, bag type had a larger influence (incubation procedure x bag type, $P = .02$) on IADF concentrations when samples were incubated in situ than in vitro, whereas the interaction was not significant ($P = .42$) for hay samples. Recoveries differed from STD (100.1%) for IS/1020 (105.6%; $P = .04$) and IS/F57 (107.5%; $P = .01$) but not for IV/1020 (97.1%; $P = .23$) or IV/F57 (96.2%; $P = .12$). Despite differences in absolute amount of IADF compared with STD, using bulk in vitro incubation with either Ankom #1020 or Ankom #F57 polyester bags resulted in acceptable fecal recoveries for cattle consuming fescue hay.

Key Words: Festuca arundinacea, Intake, Markers

520 In vitro fermentation patterns of individual and mixed major forage carbohydrates using a computerized gas monitoring system. J.J. Lee* and J.A. Shelford, *University of British Columbia, Vancouver, B.C. Canada.*

This experiment was conducted to study the fermentation profiles of individual major forage carbohydrates and to compare those results with that of their mixture. The prepared samples included starch, glucose, xylose, cellulose and the mixture comprising 25% of each carbohydrate. A modified version of a computerized gas monitoring system developed

by Pell and Schofield was used to measure the gas production up to 24 hr. Strained rumen fluid from two nonlactating cows was mixed and the mixture used as inoculum for the gas production measurements. About 150 mg of substrate was weighed in quadruplicate into flasks to which 12 ml of preheated phosphate-bicarbonate medium and reducing solution was added. Gas production rate and lag phase was estimated by an iterative least-squares procedure (PROC NLIN) with the SAS (1990) software package. Estimates generated for each substrate were analyzed using the General Linear Models Procedure of the SAS (1990). Gas production per 100 mg of substrate was 23.17 ml for glucose followed by 21.33, 19.14, 18.49, and 15.13 ml for xylose, starch, mixture and cellulose respectively. All values were significantly different ($p < 0.05$) except between mixture and starch. Starch showed longest (2.23 hr) lag time which was unexpected and lag times for xylose, cellulose, glucose, and mixture were 1.38, 1.08, 0.86, and 0.86 hr, respectively. They were significantly different from each other except between glucose and mixture ($p < 0.05$). Gas production rates differed significantly. Glucose showed highest value (0.31 ml/hr) followed by mixture, xylose, starch, and cellulose (0.2, 0.15, 0.06, and 0.05 ml/hr, respectively). Total gas production of mixture gave a similar pattern to that of cellulose which was the lowest and the lag phase for mixture showed strong similarity to that of glucose which was the highest. It is concluded that the fermentation pattern of mixture relates the individual carbohydrate sources.

Key Words: carbohydrate, fermentation, gas

521 The Accuracy of Using an Accepted Dry Matter Digestibility Prediction Equation on Alfalfa and Mixed Grass Hays. D. Chatman*, D. Miller, J. Spain, R. Belyea, and M. Eilersieck, *University of Missouri Columbia*.

The National Alfalfa Hay Quality Committees equation for predicting digestible dry matter of legumes, grasses, and legume grass mixtures from ADF is: $DDM = 88.9 - (.779 \times ADF\%)$. However, large differences in fiber-lignin complexes between grasses and legumes make it questionable to use the same prediction equation across a wide range of forage species. The objective of this study was to compare digestible dry matter as predicted by a universal equation to in situ measurements of the digestible dry matter of alfalfa and mixed grass hays. Forage samples used in this experiment were from the 1998 Missouri State Fair hay contest and included alfalfa and mixed grass hay samples. Representative samples were collected from two bales of each forage and composited. Samples were analyzed for DM, ADF, NDF, and CP using standard analytical procedures. Alfalfa ($n=16$) and the mixed grass hay samples ($n=8$) were dried, ground (2mm), and digested in situ in a ruminally fistulated cow fed a standard lactation diet. Incubation times were 0, 12, 24, and 36 hours. The 24-hour in situ incubation time was used as the estimated dry matter digestibility, and averaged 58.7% (SE= 1.8), and 56.0% (SE= 2.6), for alfalfa and mixed grass hay, respectively. Data were analyzed by analysis of covariance in which ADF was the covariant. Differences between treatment regression coefficients were tested to determine the rate of change in digestible dry matter as affected by changes in ADF. Regression coefficients of the alfalfa and mixed grass hay samples (0.88 and 1.90, respectively) differed significantly ($P = .02$). These results suggest that the current digestible dry matter prediction equation cannot be accurately applied to mixed grass hays. These results have important implications in the calculation of RFV for mixed grass hays.

Key Words: grasses, alfalfa, digestibility

522 Advances in bermudagrass research involving new cultivars for beef and dairy production. G. M. Hill*¹, R. N. Gates², and J. W. West¹, ¹*The University of Georgia, Tifton*, ²*USDA-ARS, Coastal Plain Exp. Sta., Tifton, GA*.

Bermudagrass (*Cynodon dactylon*) is a dominant warm-season perennial in the southern USA that is persistent on sandy, acidic soils of the region. Bermudagrasses are grazed or harvested for hay from April to October, and produce forage year around in tropical regions of Africa, Central America and South America. Coastal bermudagrass, released in 1943, was one of the first hybrid cultivars, and it remains the preferred cultivar grown on more than 5 million ha in the USA. Hybrid bermudagrasses are sterile and must be propagated vegetatively from roots and rhizomes, although some cultivars may be established using advanced maturity green top-growth. Seeded selections and varieties are being marketed, and some have been persistent over wide regions. However,

few have DM yields and forage quality comparable with hybrid cultivars such as Tifton 44', Tifton 78' and Tifton 85'. Tifton 85 (released in 1993) has become the premier hybrid for the lower South, exhibiting rapid establishment from rhizomes or top-growth, which allows hay production in the establishment year. In small plot and grazing trials Tifton 85 has consistently had higher DM yield and forage digestibility than Coastal or Tifton 78, resulting in improved grazing performance. In recent experiments, Coastal, Tifton 78 and Tifton 85 hays were evaluated for quality, using in vitro, in situ, and total tract digestibility techniques, and superior Tifton 85 hay digestibility was observed. Although ADF, NDF and hemicellulose were higher for Tifton 85 hays than other hays, Tifton 85 had lower concentrations of both lignin and ether-linked ferulic acid. This might explain why high-fiber Tifton 85 has higher digestibility than Coastal. Research with dairy cattle indicated that acceptable milk yields were achieved during late autumn and winter when Tifton 85 or alfalfa hay comprised up to 30% of the DM of the TMR. Future research challenges for plant geneticists will focus on improved forage quality, winter hardiness and broadened areas of adaptation for bermudagrasses.

Key Words: Cynodon, Forage, Cattle

523 In vitro digestion kinetics as influenced by forage species and harvest date. D.J.R. Cherney*, J.H. Cherney, and L.E. Chase, *Cornell University, Ithaca, NY*.

Dairy producers are incorporating more perennial grasses into their nutrient management strategies. Perennial grasses of similar chemical composition may vary in their digestion kinetics, which would alter intake potential by dairy cows. Objectives were to compare digestion kinetics of orchardgrass (1st and 2nd cutting, OG1 and OG2, respectively) and tall fescue (1st and 2nd cutting, TF1 and TF2, respectively) to a 1st cutting alfalfa (ALF1). The alfalfa was harvested at 37% NDF in late May. The OG1 and TF1, harvested a week later, analyzed 47% NDF, while OG2 and TF2, harvested in August, contained 52% NDF. Alfalfa in vitro true digestibility at 48h (82.6%) was intermediate between first cutting (86.7%) and second cutting grasses (77.3%). Lower in vitro digestion of second cutting grasses was attributed to higher lignin than in first cutting grasses. In vitro digestion was negatively correlated with lignin ($r = -.87$). Second cutting grasses had higher rates of digestion ($P \leq .05$) than first cutting grasses (.0530/h \pm .001 vs. .0233/h \pm .009). The ALF1 was intermediate with a rate of digestion of .0437/h. Indigestible residue of OG1 (12.5%), TF1 (13.4%) and TF2 (13.4%) were lower than for ALF1 (16.7%), but OG2 had the highest indigestible residue (22.65%). The OG2 also had lower potentially digestible fiber (28.8%) than the other grasses (33.3, 34.7 and 38.2% for OG1, TF1 and TF2, respectively). These results suggest that the intake potential of OG2 might be lower than for the other grasses. \leq

Key Words: Digestion kinetics, Grass, Fiber

524 Milk production of fall-calving cows during summer grazing. L. D. Satter*, Z. Wu, V. R. Kanneganti, and L. J. Massingill, *US Dairy Forage Research Center, USDA-ARS, and University of Wisconsin, Madison*.

Intensive rotational grazing of dairy cows can be an economic way for milk production, but usually does not allow milk yield in early lactation to be maximized. To better capitalize on the potential economic advantage of grazing, as well as the cow's milking potential in early lactation, a fall-calving strategy was evaluated for 2 yr. In each year, cows calved during September and October. After calving, cows were fed a TMR, then grazed from April to August for 11 wk in yr 1 and 18 wk in yr 2. At the beginning of grazing, cows averaged 220 DIM (SD 15) in yr 1 and 203 DIM (SD 17) in yr 2. In yr 1, the pasture had two distinct types of paddocks, one containing mixed grasses only and one containing mixed grasses, white clover, and red clover. The clover species accounted for 26% of the forage in the mixed paddocks. In yr 2 all paddocks were similar, containing almost all grass. A supplement mix consisting mainly of high moisture ear corn and roasted soybeans was fed during grazing at 6.2 kg/d in yr 1 and 7.9 kg/d in yr 2 (DM basis). This accounted for approximately 35 to 40% of total DMI. In each year, 40 cows (20 primiparous in yr 1 and 12 primiparous in yr 2) were grazed. In yr 1, 27 cows grazed the grass paddocks and 13 grazed the mixed paddocks. In yr 2, all 40 cows grazed grass paddocks as one group. Milk yield during the grazing season in yr 1 averaged 19.1 and 20.4 kg/d (SE .5, $P < 0.05$) for the all-grass pasture and the grass-legume pasture, respectively. The

yield declined 2.2 kg/d the first week cows were turned out to pasture for the two groups, with the decline being less with the grass-legume pasture than for the all-grass pasture. Milk yield averaged 21.4 kg/d (SE .6) during grazing in yr 2, with a decline of 4.2 kg/d occurring in the first week. Milk production for 308 d of lactation was: yr 1, 8873 kg for cows on all grass, and 9145 kg for the mixed grass-legume pasture; yr 2, 10055 kg for cows on all grass pasture. Production was markedly higher for these fall-calved cows pastured in late lactation compared to spring-calved cows pastured in early lactation under similar conditions (7114 kg, Dhiman and Satter, 1996). While milk production still declined in late lactation upon turning cows out to pasture, the cumulative loss was much less than with early lactation cows.

Key Words: Pasture, Clover, Grazing

525 Fermentation characteristics of alfalfa and whole crop barley round bale silage as influenced by bag type. G. R. Khorasani* and J. J. Kennelly, *University of Alberta, Edmonton, AB, Canada.*

Objective of this study was to evaluate the fermentation characteristics of round bale alfalfa and whole crop barley silage ensiled in different types of silage bags at two different dry matters (DM). Crops were ensiled at 60-70% and 35-40% DM. At ensiling, each crop was ensiled in three sets of silage bags (replicates) with three bales in each bag representing a treatment. For the silage bags, two different colors (white vs. black and white) and two different thicknesses (3.5 vs. 4.0 mil) were used as experimental treatments. After ensiling, samples were taken from each bag on day 1, 2, 3, 5, 7, and weekly for an additional 6 weeks. A repeated measurement design was used to determine the effects of forage type, forage moisture, and thickness and color of the bag on the fermentation characteristics of ensiled crops. The pH changes during the storage were very small and the effect of forage type, moisture and thickness were significant ($P < 0.05$). The temperature of silage was higher in the high moisture silage than in the low moisture silage. Crops ensiled in the thinner bags had a higher temperature than crops ensiled in the thicker bags (32.2 vs. 29.3 °C, $P < 0.05$). Color of the bag did not affect the ensiled temperature. The protein fractions for the high moisture silage were different from low moisture silage, but the thickness and color of the bag had no effect on the chemical composition of the silages. High moisture silage had a higher lactic acid content than low moisture silage (2.8 vs. 6.6 mg/g DM, $P < 0.05$), but no significant differences were observed due to silage type or bag color. Effect of bag type on acetate, ethanol, and methanol concentration of the silage was not significant, but forage type and forage moisture affected these parameters. We concluded that management factors such as DM content of ensiled forage significantly influenced the fermentation characteristics of ensiled crops, but the effect of bag type was relatively small.

Key Words: Silage Fermentation, Round Bale Silage

526 Tasco™: Influence of brown seaweed on antioxidants in forages and livestock. V. G. Allen*¹, K. R. Pond¹, J. P. Fontenot², K. E. Saker², C. P. Bagley³, R. L. Ivy⁴, R. R. Evans⁴, R. E. Schmidt², J. H. Fike², and D. B. Webster¹, ¹Texas Tech University, Lubbock, ²Virginia Tech, Blacksburg, ³Sam Houston State University, Huntsville, TX, ⁴Mississippi State University, Prairie.

Increased antioxidant activity in both plants and animals diminishes oxidative stress. Seaweed (*Ascophyllum nodosum*) is a known source of plant growth regulators and application of Tasco™-Forage (a proprietary seaweed-based product) to grasses increased activity of the antioxidants superoxide dismutase (SOD), glutathione reductase, ascorbate peroxidase, and vitamin precursors in several forage grasses. Tasco was applied to tall fescue (*Festuca arundinacea* Schreb.) pastures infected and non-infected with the endophyte fungus, *Neotyphodium coenophialum*. Both monocyte major histocompatibility complex class II expression and phagocytic activity were decreased ($P \leq .05$) in steers due to endophyte infection but this effect was reversed ($P \leq .05$) by Tasco application. Effects on immune function were measured after cross-country transportation to the feedlot and throughout the finishing period. Steers that had grazed the Tasco-treated pastures had higher ($P \leq .05$) marbling scores regardless of the endophyte and this was reflected in higher ($P \leq .15$) USDA quality grades. At slaughter, vitamin E in liver was increased ($P \leq .06$) in steers that had grazed the treated pastures. Color stability and beef shelf-life were enhanced. The mode of action may be at least in part through effects on antioxidant activity including vitamin

E. Direct supplementation of Tasco to beef, swine, and horses has provided further evidence of improved immune response and/or increased shelf-life. Tasco may provide opportunities to reduce oxidative stress in plants and animals.

Key Words: Immune function, *Ascophyllum nodosum*, Carcass characteristics

527 Alleviating tall fescue toxicosis with non-toxic endophytes. M.A. McCann*¹, J.A. Bondurant¹, L.L. Hawkins¹, N.S. Hill¹, C.S. Hoveland¹, F.N. Thompson¹, G.C.M. Latch², and J.H. Bouton¹, ¹University of Georgia, Athens, ²AgResearch Grasslands, Palmerston North, New Zealand.

The presence of a fungal endophyte (*Neotyphodium coenophialum*) in tall fescue has been shown to positively impact plant persistence and agronomic performance. However, previous studies indicate that livestock ingestion of endophytically derived ergot alkaloids in tall fescue forage results in poor animal weight gain and depressed reproduction, a condition referred to as "fescue toxicosis". The objective of the present study was to evaluate serum prolactin levels and animal performance in lambs on endophyte-infected (E+) tall fescue cultivars, endophyte-free (E-) cultivars, and cultivars after removal of their naturally occurring *N. coenophialum* endophyte and re-infection with nontoxic endophyte strains (NT). These NT endophyte strains had nil ergot alkaloid production. Jesup NT, Georgia 5 NT, and Kentucky 31 NT cultivars were compared to Jesup E+ and Jesup E- cultivars. Grazing trials were conducted at the Central Georgia Branch Station in Eatonton, GA in the spring and fall of 1998 and 1999. Lambs weighing approximately 23 kg were stocked on 930 m² paddocks. Put and take grazing was utilized to ensure similar forage availability among paddocks (2000 kg DM/ha). Animal weights and serum prolactin levels were measured along with available forage yield and forage ergot alkaloid concentration every two weeks. All cultivars with the NT endophytes produced none of the toxic ergot alkaloids in their forage and were similar to the E- paddocks in this regard. Serum prolactin was reduced ($P < .05$) in the lambs grazing E+ tall fescue as compared to lambs on E- forage. Animals consuming forage with NT endophytes showed blood prolactin levels similar ($P > .05$) to lambs on E- paddocks indicating a lack of toxicity. The lambs grazing NT paddocks also showed weight gains higher ($P < .05$) than lambs on E+ forage and similar ($P > .05$) to lambs on E- forage. These results indicate that infecting select tall fescue cultivars with NT endophytes is a promising strategy for alleviating the negative effects of fescue toxicosis.

Key Words: tall fescue, *Neotyphodium coenophialum*, nontoxic endophytes

528 Supplementation of Growing Heifers Grazing Stockpiled Fescue. M.E. Scott*, M.H. Poore, J.T. Green, S.P. Morgan, and H.K. Jones, *North Carolina State University, Raleigh.*

A two year 83-d winter grazing study was conducted to evaluate nutrient concentration of stockpiled fescue (98% endophyte infected), and performance of beef heifers stripgrazed with or without supplementation. Thirty-six AngusX heifers (initially 265 kg in yr 1 and 257 kg in yr 2) were managed as 6 groups, and half were given .33% of body weight (.9 kg dm) whole cottonseed plus a small amount (.2 kg dm) of concentrate per head. Fescue was fertilized with 76 kg N/ha on Sept 1, and initial forage mass was 4499 kg/ha in yr 1 and 5917 kg/ha in yr 2. Grazing and forage sampling started Dec 3 in yr 1 and Nov 25 in yr 2. Forage quality was higher ($P < .01$) in yr 1 {16.8% CP and 82.0% in vitro true organic matter digestibility, (IVTOMD)} than in yr 2 (12.6% CP and 71.9% IVTOMD). In yr 1, CP and IVTOMD declined until late winter when both recovered (Linear and Quadratic, $P < .05$). In yr 2, CP remained stable and IVTOMD declined (Linear, $P < .05$). Green and brown tissue were both higher ($P < .01$) in quality during yr 1 (green; 20.4 % CP and 90.5 % IVTOMD, and brown; 10.3 % CP and 63.9 % IVTOMD) than in yr 2 (green; 15.3 % CP and 87.2 % IVTOMD, and brown; 8.4 % CP and 61.7 % IVTOMD). Fescue was initially 79 % green and declined to 62 % in yr 1, and was initially 80 % green and declined to 54 % in yr 2. Heifers gained more in year 1 than year 2 ($P < .05$), responded to supplementation ($P < .01$), and displayed a supplement by year interaction ($P < .05$). Shrunken ADG for unsupplemented heifers was .46 kg/d in yr 1 and .22 kg/d in yr 2, and for supplemented heifers was .56 kg/d in yr 1 and .44 kg/d in yr 2. BUN was higher ($P < .01$) for supplemented heifers in both years (9.5 vs 10.5 mg/dl in yr 1 and 7.2 vs 8.6 mg/dl in yr 2). Forage organic matter intake (OMI) determined by

pasture mass difference was 3.29 kg/d in yr 1 and 3.79 kg/d in yr 2 and was not influenced by supplementation, while total OMI was increased ($P < .05$) by supplementation in both years. Pasture forage mass after grazing (2490 kg/ha) suggested that intake was not limited based on forage availability.

Key Words: Stockpiled fescue, Cottonseed

529 A novel system to estimate protein degradability in legume and grass hays. M.E. Dorshorst and P.C. Hoffman, *University of Wisconsin, Madison.*

Previous research from our laboratory has demonstrated that near-infrared reflectance spectroscopy (NIRS) has a utility in predicting RUP contents of legume and grass silages. This study was conducted to evaluate whether application of previous research techniques could yield a useful NIRS RUP prediction system for legume and grass hays. In 1998 and 1999, legume and grass hays ($n = 208$) from the north central region of the United States were collected. A portion of each sample was dried, ground (1 mm), and scanned on a NIR spectrophotometer and spectra saved. Center and select procedures using Infrasoft International[®] software (version 2) were implemented and 106 spectrally different legume and grass hays were selected for NIRS RUP equation development. The remaining portion of the legume and grass hay samples were dried, ground (2 mm) and evaluated for RUP using calibrated cow ($n = 4$) in situ procedures. Legume and grass hays were also evaluated for CP and NDF. The legume and grass hays ($n = 106$) were of desired variable quality with CP ranging from 10.7 to 29.7% of DM, and NDF ranging from 26.8 to 61.5% of DM. In situ RUP content ranged from 14.6 to 45.5% of CP, with a mean of 25.9% of CP. Development of an NIRS RUP equation for legume and grass hays proved to be fruitful. The R^2 and SE of calibration were 0.87 and 2.46% of CP, respectively. Validation procedures also indicated reasonably good performance of the equation with an r^2 of 0.83 and a SE of cross validation of 2.84% of CP. Data indicate NIRS can predict in situ RUP contents of legume and grass hays.

Key Words: Forage, Protein, Degradability

530 Genotypic differences in chemical composition and ruminal degradability of oat hulls. R. K. Thompson^{*1}, A. F. Mustafa¹, J. J. McKinnon¹, D. D. Maenz², and B. Rossnagel³, ¹*University of Saskatchewan, Saskatoon, Canada*, ²*Prairie Feed Resource Center, Saskatoon, Canada*, ³*Crop Development Center, Saskatoon, SK, Canada.*

A study, consisting of two trials, was conducted to determine differences in chemical composition and ruminal nutrient degradability of hulls derived from ten varieties of oat grown in western Canada. In trial one, chemical composition and IVDMD of the oat hull varieties were determined in a completely randomized design. Based on the results of the first trial, a second trial was conducted to compare in situ ruminal nutrient degradability of hulls from two of the oat varieties (AC Assiniboia and Calibre) with that of oat straw (Calibre) in a randomized complete block design. Results showed that relative to the other nine varieties, hulls derived from AC Assiniboia had a lower ($P < .05$) ADL and a

higher ($P < .05$) IVDMD. Relative to the average of the other nine varieties, AC Assiniboia had 79% less ADL and 44% higher IVDMD. There were no significant differences in ADF, NDF, and CP content between varieties. Results of the second trial showed that effective ruminal degradability of NDF and ADF for the AC Assiniboia hulls were similar to those of Calibre straw but higher ($P < .05$) than those of the Calibre hulls (22.5% vs. 11.8% and 22.3% vs. 12.5%, respectively). The higher effective degradability of the AC Assiniboia hulls relative to the Calibre hulls was due to a larger ($P < .05$) slowly degradable fraction. The results of this study show that due to their lower ADL content, hulls derived from AC Assiniboia oat have almost double the ruminal fiber degradability of Calibre hulls. The economic return for the oat milling industry may be increased by using an oat variety with a more valuable hull to sell into the feed market.

Key Words: Oat hulls, Chemical composition, Ruminal Degradability

531 Effect of undegradable intake protein supplements, forage protein level, and incubation time on *in vitro* fermentation. L.A. Richards^{*1}, M.K. Petersen², J.B. Richards², and M. Remmenga², ¹*USDA-ARS Grazinglands Research Laboratory, El Reno, OK*, ²*New Mexico State University, Las Cruces.*

High undegradable intake protein (UIP) supplements may interact with changing forage quality to affect ruminal fermentation. Two *in vitro* experiments investigated changes in OMD, NH_3 and VFA production when supplying UIP with range diet samples (3,8, or 13%CP) over 18 or 48 h. In Experiment 1, forage was not supplemented (NS); supplemented with wheat middlings (WM; 23%CP); WM + feathermeal (FM) at 7,16, or 23%UIP (32,44, or 55%CP); or CSM (16%UIP, 33%CP). In Experiment 2, forage was NS; supplemented with WM (17%CP); or WM + 9,12, or 15%UIP at 34%CP. Forage (F), supplement (S), and time (T) interactions were tested. In Experiment 1, OMD was increased by S vs NS (33 vs 40 ± .4%; $P = .01$), T at 18 vs 48 h (29 vs 48 ± .3%; $P = .01$), and F at 3,8, and 13%CP (31,40, and 45 ± .3%; $P = .01$). Higher NH_3 (SxT; $P = .01$) was detected as UIP increased at 48 h. Acetate:propionate decreased as forage CP increased, but increased with NS and higher UIP (SxF; $P = .01$). Total VFA were increased as forage CP increased, but decreased as supplemental UIP increased (SxF; $P = .01$). While UIP source did not change OMD ($P = .3$) or NH_3 ($P = .7$), FM increased VFA (65 vs 61 ± .8 mMol; $P = .01$) and decreased acetate:propionate (3.5 vs 3.7 ± .03; $P = .01$) vs CSM. In Experiment 2, supplementation increased OMD in lower CP forage (SxF; $P = .02$). NH_3 was lowest ($P = .01$) in NS and highest ($P = .01$) in WM+FM at 9%UIP. Acetate:propionate was decreased by higher WM and higher forage CP (SxF; $P = .01$). Lowest isovalerate, valerate, and isobutyrate were found in NS and highest in 8% CP forage (SxF; $P = .04$). Total VFA was decreased ($P = .01$) at 48 h in NS vs S (60 vs 75 ± 1.6 mMol) and increased ($P = .01$) at highest forage CP (68, 69, 79 ± 1.3 mMol). Higher UIP in a moderate protein supplement optimized *in vitro* forage fermentation. Nutrient availability had less effect on fermentation of higher protein forage. While forage degradation was consistently increased in the first supplemental increment, additional inputs which alter nutrient flow may improve animal performance.

Key Words: UIP, forage, fermentation

GOAT SPECIES

532 Effects of individual vs group confinement and forage access on performance of artificially reared, confined Alpine kids. A.L. Goetsch^{*}, G. Detweiler, T. Sahl, L.J. Dawson, and S.S. Zeng, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Forty Alpine kids (20 females and 20 males) were used to determine effects on performance of individual vs group confinement and access to forage during the suckling period. Kids began the experiment at 3 to 9 d after birth (3.6 ± .10 and 4.0 ± .09 kg initial BW for females and males, respectively). Treatments were: individual confinement in 91 × 91 cm cages (C1); confinement of two kids (one in the experiment and another older) in 182 × 91 cm cages (C2); group confinement (with at least two older kids present) in a 2.43 × 1.22 m pen (P); and P plus free access to alfalfa hay (PF). Milk was consumed ad libitum for 8 wk with free access to a concentrate-based starter diet, followed by a 4-wk post-weaning period, the first 5 d of which entailed restricted milk intake.

In the 8-wk suckling period, milk intake was similar among treatments (1.81, 1.80, 1.89, and 1.77 kg/d; SE = 34.8), whereas sex influenced the treatment response in ADG (interaction, $P = .02$) (female: 159, 154, 172, and 154 g/d; male: 175, 193, 162, and 182 g/d for C1, C2, P, and PF, respectively [SE = 6.3]). In the 4-wk post-weaning period, ADG was greater ($P < .05$) for P than for C2 and PF (75, 54, 112, and 49 g/d; SE = 16.4), although for the entire 12-wk experiment ADG was similar among treatments (137, 134, 149, and 128 g/d for C1, C2, P, and PF, respectively; SE = 6.7). In conclusion, housing two or more Alpine kids together vs alone and offering hay during the suckling period did not enhance performance during or shortly after suckling.

Key Words: Goat, Suckling, Performance

533 Effect of chromium picolinate supplementation on the number of blood leukocytes and weight gain of early-weaned goat kids. F.G. Rios^{*1}, F.A. Nuñez², G. Zambrano², J.A. Ortega², and R. Barajas¹, ¹Universidad Autonoma de Sinaloa, ²Universidad Autonoma de Chihuahua, Mexico.

The objective of this experiment was to examine the effect of chromium (Cr) picolinate supplementation on the number of blood leukocytes and ADG of early-weaned goat kids. Fifty goat kids (male and female; Alpine, Saanen and Toggenburg breed) were used. Animals were weaned five days after birth and divided into five groups of 10 goats. Each group was randomly assigned to one of five treatments: 1) No Cr supplementation (control); 2) 100 ppb Cr (from chromium picolinate) supplemented in milk substitute (Cr-Pic 100); 3) Feed supplement with 200 ppb Cr (Cr-Pic 200); 4) Feed supplement with 300 ppb Cr (Cr-Pic 300); and 5) Feed supplement with 400 ppb Cr (Cr-Pic 400). Goat kids were fed the experimental supplements for four weeks. Body weight were taken at the start and end of the experiment. Blood samples were taken weekly from the jugular vein in vacutainer tubes without anticoagulant. One week after weaning, Cr supplementation decreased ($P < 0.05$) the number of blood leukocytes (23,585 vs 17,802 leukocyte/mm³). Two weeks after weaning, Cr-supplemented goats showed lower ($P < 0.05$) leukocyte numbers (19,686 vs 14,307 leukocyte/mm³). In the third week after weaning, goat kids supplemented with 200 to 400 ppb Cr showed lower leukocytes values ($P < 0.05$) than the control (13,172 vs 10,324 leukocyte/mm³). Four weeks after weaning, Cr supplementation had not effect ($P > 0.10$) on the number of blood leukocytes (mean: 7,420 leukocyte/mm³). Compared to the control, ADG increased ($P < 0.05$) 24.8% by addition of Cr-Pic 300 (145 vs 181 g/d), and 29.7% by addition of Cr-Pic 400 (145 vs 188 g/d). Chromium supplementation with 100 and 200 ppb had not effect ($P > 0.10$) on ADG. It is concluded that Cr picolinate supplementation reduced the number of blood leukocytes and that levels higher than 300 ppb improved ADG in early-weaned goat kids.

Key Words: Chromium, Picolinate, Goat

534 Effects of dietary protein level on performance of weaned Boer crossbred and Spanish wethers. I. Prieto¹, A.L. Goetsch¹, S.A. Soto-Navarro^{*1}, V. Banskalieva¹, M. Cameron¹, R. Puchala¹, L.J. Dawson¹, and S.W. Coleman², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Grazinglands Research Laboratory, USDA, ARS, El Reno, OK.

Boer (3/4) × Spanish (1/4) (BC; n = 23) and Spanish (SP; n = 22) wethers, approximately 4.5 mo of age and 17.6 and 19.4 kg initial BW, respectively (SE = .57), were used to determine effects on growth of protein level in 70% concentrate diets consumed ad libitum for 30 wk. Diets offered were 10.2, 14.2, 18.3, and 23.6% CP (DM basis), and CP concentration in consumed DM was 9.3, 13.8, 17.1, and 22.1% (P1, P2, P3, and P4, respectively), with supplemental protein from soybean meal for P1 and P2 and from soybean meal plus a blend of blood, fish, and feather meals for P3 and P4. Dry matter intake was similar between breeds and among diets (732, 712, 698, and 740 g/d for P1, P2, P3, and P4, respectively; SE = 27.0). Average daily gain was greater for P2 ($P = .07$) and P4 ($P < .05$) than for P1 (76, 90, 85, and 100 g/d for P1, P2, P3, and P4, respectively; SE = 5.3) and for BC vs SP (97 vs 78 g/d, SE = 3.7; $P = .05$). Similarly, ADG:DMI was lowest ($P < .05$) among diets for P1 (.106, .126, .121, and .132 for P1, P2, P3, and P4, respectively; SE = .0053) and greater ($P < .05$) for BC than for SP (.135 vs .108; SE = .0037). In conclusion, with 70% concentrate, dietary protein levels above 14% DM did not improve performance for either weaned Boer crossbred or Spanish wethers.

Key Words: Goat, Protein, Growth

535 Effect of dietary protein degradability and liveweight on blood metabolites in prepubertal female goats. G. Cufre*, O. Forchetti, M. I. Vazquez, L. Godio, and M. Chaves, Universidad Nacional de Rio Cuarto, Cordoba, Argentina.

The objective of this work was to determine the effects of BW and dietary protein degradability level on the onset of puberty by measuring changes of some blood metabolites as indicators of the metabolic status of goats. The experiment was carried out at Rio Cuarto, Argentina (33°08'S, 64°20'W) between February and August, under natural photoperiod condition. Four-month old prepubertal Creole female goats

were assigned to three treatments (n = 9) differing in protein degradability: 70% (HD), 63% (MD) and 60% (LD), and formulated to be isonitrogenous (20% crude protein) and isocaloric (2.64 Mcal/kg DM). Does were stratified by BW in two subgroups: 15.8 ± 1.4 (HW) and 11.9 ± 1.4 (LW) at the beginning of the experiment. Feed was offered in individual cages from 0800 to 1600. Body weight was recorded at monthly intervals. Estrus behavior was recorded twice daily using a vasectomized male. Ultrasonography was performed on d 4 and 6 after estrus to record corpus luteum. Blood samples were collected every 2 wk to measure blood urea nitrogen, cholesterol, glucose, and non-esterified fatty acids (NEFA). A 2 × 3 factorial with two BW and three protein degradability levels was analyzed in a randomized complete block design. Puberty was defined as occurrence of estrus and presence of corpus luteum. Puberty occurred in 23 of 27 goats within an interval of 20 d. There were no differences in blood metabolite levels between the two subgroups of goats (HW and LW). Glucose concentration was always within the range of reference values, although it was higher in LD ($P < .01$) than in HD or MD. The NEFA levels did not differ between diets but were always below 0.5 mmol/L. As puberty approached, cholesterol concentrations increased in all goats. Puberty age was not affected by diet and BW (HW 20.3 ± 2.2 kg and LW 16.3 ± 1.4 kg). Results from this study indicate that once a certain maturity is achieved, puberty appears to be controlled by metabolic status reached regardless of BW.

Key Words: Metabolic Status, Prepubertal Goats, Protein Degradability

536 Intestinal digestible protein and ruminal ammonia-N in grazing goats: strategies to estimate supplement requirements. A.S. Juarez-Reyes*, G. Nevarez-Carrasco, and M.A. Cerrillo, Universidad Juarez del Estado de Durango, Durango, Dgo. Mexico.

The objective of this study was to use the intestinal digestible protein (IDP) system to evaluate the energy and nitrogen balance from the diet consumed by goats in a kid production system in a semiarid region of Northern Mexico. Four ruminally and esophageally fistulated female goats (38 ± 1.7 kg BW) from a flock of 250 grazing goats were used for a period of 12 mo to obtain ruminal fluid and diet samples. Crude protein (CP), OM, IVDMD, *in situ* degradability of CP and EE from the diet were used to estimate the intake of intestinal digestible protein (IIDP) that originated from nitrogen (NIDP) and energy (EIDP), and the intake of metabolizable energy (IME). Ruminal samples were analyzed for ammonia-N (NH₃-N) concentrations. Data were analyzed in a randomized complete block design. Annual means for CP, IVDMD, *in situ* degradability of CP, EE, IME and IIDP were: 15.0%, 54.6%, 36.0%, 1.6%, 2.6 Mcal/d and 112 g/d, respectively. The mean ruminal fluid concentration of NH₃-N registered during the dry season (February-June) was 4.8 mg/dL, whereas a range of 6 to 19 mg/dL was recorded during the rainy months (July-December). The mean content of the diet in IDP throughout the year was 82 g/kg DM. This intake of IDP is sufficient to meet maintenance requirements and to produce 500 mL of milk. However, significant effects ($P < 0.05$) between EIDP (mean 90 g/kg DM) and NIDP (mean 75 g/kg DM) were observed during the dry season. The 15 g/kg difference in favor of EIDP suggests the necessity to incorporate this amount of digestible protein to the diet of goats during the harsh season to increase the intake of metabolizable protein.

Key Words: Goats, Grazing, Intestinal Digestible Protein

537 Estimating fecal crude protein excretion in goats. A.L. Adams^{*1}, J.E. Moore², A.L. Goetsch¹, and T. Sahu, ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Department of Animal Science, University of Florida, Gainesville.

As part of an overall goal to estimate protein requirements of goats using the factorial method, equations were developed and tested to estimate fecal CP excretion. Data from 54 trials (n = 189) on CP intake and apparent digestibility in goats were compiled. There were 78 unsupplemented roughages (14 grass hays, 12 legume hays, 4 grain silages, 4 straws, 9 mixed roughage sources, and 35 browse and mixed browse/hay diets) and 111 mixed roughage/concentrate diets in the database. Hypotheses were 1) metabolic fecal CP as a proportion of DMI is constant and 2) true digestibility of CP is constant, and were tested by regressing apparent digestible CP (DCP, % diet DM) on total CP (% DM). Excluding extreme outliers, the equation was: DCP = .899 (CP) - 3.14; n = 179; r² = .96; intercept = metabolic fecal CP excretion (% DM); and

slope = true digestibility of CP. Coefficients from the regression equation were used to compute expected fecal CP (EFCP, g/d): $EFCP = .0314 (TDMI) + [1 - .899 (CP/100)(TDMI)]$, where TDMI = total DM intake (g/d). To evaluate the EFCP equation, the main database was divided into subsets for equation development (n = 107) and evaluation (n = 68). Subsets were balanced for TDMI, CP intake, CP digestibility, dietary forage % (FORG), presence or absence of browse in the diet (BRWZ; 1 vs 0, respectively), animal age, breed, and initial BW. Regression of actual fecal CP excretion (AFCP, g/d) on EFCP using the development set yielded the equation: $AFCP = 1.160 (EFCP) - 2.30$; $r^2 = .89$, RMSE = 11.4. The slope of the equation was different from 1 ($P < .0001$). Multiple regression analysis conducted on the development set, using factors chosen with the stepwise selection option of PROC REG, gave the following equation: predicted fecal CP (PFCP, g/d) = $-9.79 + 1.181 (EFCP) + 12.32 (BRWZ) + .0522 (FORG)$; $r^2 = .92$; RMSE = 9.9. Testing this equation with the evaluation subset showed that the regression of AFCP on PFCP was close to ideal (i.e., intercept = 0, slope = 1, $r^2 = .93$, RMSE = 9.3). In conclusion, when predicting fecal CP excretion by goats, forage concentration and presence or absence of browse in the diet should be considered in addition to dietary CP concentration and TDMI.

Key Words: Protein, Excretion, Goats

538 Effect of saltbush (*Atriplex amnicola*) on performance of goats on saline rangelands. S. H. Raza^{*1}, M. Riaz¹, and P. N. Raza², ¹University of Agriculture, Faisalabad, Pakistan, ²Hi-Tech Feeds, Rawalpindi, Pakistan.

Fifteen lactating Beetal goats were randomly allotted to three diets. In diet A (control), goats were fed hay containing Lucerne (*Medicago sativa*) and Mott grass (*Pennisetum purpureum*) in an equal ratio. In diets B and C, 20 and 40% DM of diet A was replaced with an equal percentage of DM from saltbush (*Atriplex amnicola*). Diets were fed individually; goats had ad libitum access to diets for a period of 6 wk in a completely randomized design. Dry matter intake (DMI), organic matter intake (OMI), water intake (WI) and milk production (MP) were recorded and feed conversion ratio (FCR) was calculated. Increasing dietary saltbush level led to decreases ($P < .05$) in DMI (1.28, 1.00, and .79 kg/d), OMI (1.13, .83, and .66 kg/d) and MP (.44, .41, and .31 kg/d) for A, B, and C, respectively. The WI was increased ($P < .05$) with increasing saltbush intake (1.69, 3.31, and 3.93 L/d for A, B, and C, respectively). No differences were seen in ADG for A, B and C. Inclusion of different levels of saltbush affected MP and milk composition ($P < .05$) for solid not fat, acidity, and ash. No difference ($P < .05$) were found in protein, specific gravity, and total solid of milk. Correlations between diet and DMI, ADG or OMI/kg W^{.75} were negative, whereas WI and diet were positively correlated. Diet had no effect on ADG and FCR, although FCR showed a positive correlation ($r = .3$) with saltbush addition. Milk production was not affected by replacing Lucerne and Mott grass hays with 20% saltbush. However, when replacing Lucerne and Mott grass hays with 40% saltbush, MP was reduced ($P < .05$). Results suggested that under range conditions and during periods of feed scarcity, saltbush could be added to goat diets up to 20% DM.

Key Words: *Atriplex amnicola*, Saltbush, Goat

539 PEG supplementation of kids and effects of early post-weaning nutritive plane upon subsequent growth. R.C. Merkel^{*1}, A.L. Goetsch¹, T. Sahl¹, and N. N. Silanikove², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Volcani Center, Bet Dagen, Israel.

Forty-eight 50% Boer × Spanish doelings (4 mo of age, 20.9 ± 2.4 kg) were randomly assigned to three treatments to test the effects of polyethylene glycol (PEG) supplementation of grazed sericea lespedeza and early post-weaning nutritive plane on subsequent growth. Treatments were: barn (B) where goats were kept in individual pens for the 24-wk trial and fed free-choice a 70% concentrate diet (17% CP, 69% TDN); PEG (P); and control (C). In the first 6 wk (Phase 1), P and C doelings grazed .44-ha lespedeza paddocks supplemented with 88 g/d of concentrate with or without an additional 25 g/d PEG. In the subsequent 6 wk (Phase 2), C doelings resided in previously ungrazed 1-ha paddocks dominated by crabgrass, whereas P doelings grazed 1-ha lespedeza paddocks supplemented with approximately 1.5% BW of the B

diet. In Phase 3, the final 12 wk, all doelings had ad libitum access to the 70% concentrate diet in confinement. Body weights were determined at 3-wk intervals and ADG was calculated by regression using initial BW as a covariate. Phase 1 ADG ranked ($P < .05$) B>P>C (157, 97, and 47 g/d; respectively, SE = 10.9). The ADG in Phase 2 (B 70, P 55, and C 57 g/d; SE = 9.3), Phase 3 (B 80, P 85, and C 73 g/d; SE = 7.6), and the whole trial (B 87, P 73, and C 56 g/d; SE = 8.2) were similar among treatments ($P > .05$). In conclusion, PEG may have potential to improve ADG by goat kids grazing tannin-containing sericea lespedeza, although testing over a longer time frame is needed. Differences in ADG in the early portion of the grazing period did not elicit increased ADG later with feeding of a concentrate-based diet relative to continuous concentrate consumption reflecting an absence of compensatory growth.

Key Words: Goats, Polyethylene Glycol, Sericea Lespedeza

540 Vegetation management with goats and steers in the Appalachian region of North Carolina. J-M Luginbuhl^{*}, J. T. Green, and M. H. Poore, North Carolina State University, Raleigh.

A field study was initiated to evaluate the effectiveness of utilizing cattle (*Bos taurus*) alone or in combination with goats (*Capra hircus*) to manage vegetation in an overgrown mountain pasture (7.8 ha) that had not been grazed for two years and to control encroaching multiflora rose (*Rosa multiflora*) bushes and black locust trees (*Robinia pseudoacacia*). The site was divided into 9 unequal sections consisting of 3 control (CTL) plots, three plots rotationally grazed by cattle (C; 6 steers) and three plots rotationally grazed by goats and cattle (GC; 12 goats and 6 steers). Measurements of herbaceous vegetation at permanent pegs placed along transect lines using a 10 x 100-cm rectangle and of tagged trees were taken immediately before and after each grazing season. Over four grazing seasons, managed defoliation resulted in an increase in percent vegetation as grass ($P < .01$), and in increased frequencies of white clover (*Trifolium repens*; $P < .02$), bluegrass (*Poa pratensis*; $P < .01$) and dandelion (*Taraxacum officinale*; $P < .01$) but also horsenettle (*Solanum carolinense*; $P < .01$) in C and GC plots, and in respective decreases in CTL. White clover was practically eliminated from CTL plots. Percent vegetative ground cover decreased in CTL (75 to 40%; $P < .01$) but remained similar in C and GC plots (avg 81%). Tall fescue (*Festuca arundinacea*) frequency was not affected and remained similar during the course of the study (avg: 67.5%). Black locust trees were practically eliminated over the four grazing seasons in both C and GC plots ($P < .01$) but grew to a height of 5.3 m in CTL. Height of multiflora rose bushes were kept low in GC (avg .6 m) but increased to 1.8 m in C and 2.5 m in CTL (C vs GC: $P < .04$; CTL vs C + GC: $P < .01$) and the number of dead multiflora rose canes (stems) increased to 59% in GC but remained at 4.5% in both C and CTL. Multiflora rose canopy area (C vs GC: $P < .05$; CTL vs C + GC: $P < .01$) increased in CTL (.5 to 11 m²) and C (.6 to 7 m²), but did not change in GC (avg .5 m²). These results indicate that goats grazed with cattle are a viable management tool for the control of unwanted vegetation in mountain pastures.

Key Words: Goat, Cattle, Vegetation Management

541 Nutrient digestibility of bean straw-based diets by goats. M.A. Cerrillo and A.S. Juarez-Reyes, Universidad Juarez del Estado de Durango, Durango, Dgo. Mexico.

Four dry non-pregnant Spanish Criollo goats fitted with ruminal and duodenal cannulae were used in a 4 x 4 Latin square design to study the effects of supplementing urea-ammoniated straw, alfalfa hay and ground milo to a bean straw-based diet on the site and extent of nutrient digestion. Four diets containing A) bean straw fed ad libitum, B) bean straw, ammoniated straw and milo, in proportions of 68, 19 and 10% respectively, C) bean straw, alfalfa and milo (75, 11 and 11%), and D) bean straw, alfalfa, ammoniated bean straw and milo (69, 10, 7 and 10%) were fed. Intakes of DM and OM, and ruminal digestibilities of DM (avg: 63.4%) and OM were similar across diets. Ruminal digestibility of NDF and ADF were higher when ammoniated straw and milo were fed ($P < .10$). Total tract digestibilities of DM (avg: 77.1%), OM, NDF and ADF were not affected by diet. Diet effects were observed in N intake ($P < .01$) and flow of microbial N to the duodenum ($P < .01$). There were no differences ($P > .7$) in microbial efficiency across diets. In conclusion, addition of ammoniated bean straw, alfalfa hay and

ground milo to a bean straw-based diet fed to goats resulted in minimal differences in digestibility.

Item	A	B	C	D	SEM	P
Intake, g/d						
DM	805	950	870	929	77.7	.13
OM	721	851	779	832	69.7	.13
Apparent ruminal digestion, %						
OM	46.0	48.6	45.0	45.5	6.1	.85
NDF	56.0	57.2	47.8	51.8	4.1	.06
ADF	58.9	59.4	52.4	53.6	2.4	.01
Apparent total tract digestion, %						
OM	58.7	65.1	62.1	64.6	4.8	.32
NDF	58.4	61.7	56.0	58.5	5.2	.54
ADF	58.0	60.8	50.8	57.6	4.7	.09
N Intake, g/d	4.8	8.3	8.4	8.6	.48	.01
Microbial-N flow, g/d	5.0	4.6	4.3	7.5	.37	.001
Microbial efficiency ^a	9.1	7.5	7.4	11.5	.35	.78

^a g bacteria-N/kg OM truly dig. in rumen.

Key Words: Goats, Bean Straw, Digestibility

542 Effect of whole cottonseed on intake, apparent digestibility and rate of passage in goats. Y. Smoot*, S. Solaiman, and Q. McCrary, *Tuskegee University, Tuskegee, AL.*

Four mature Nubian crossbred wethers were fed diets containing 0, 15, 30, and 45% whole cottonseed (WCS) in a 4 x 4 Latin square design to determine intake, digestion and passage as affected by WCS. Each diet consisted of 50% bermudagrass hay (BGH) with or without WCS supplement mixes. Periods were 21 d with 16 d of adjustment followed by 5 d of total collection of feces & urine. Ytterbium- (Yb) labeled BGH was pulse dosed on d 1 of each collection period. Feed and feces samples were analyzed for DM, CP, EE, NDF, ADF and ash to determine DMI and digestion of different nutrients. Fecal samples were analyzed for Yb to estimate passage rate. The BW were recorded at the end of each adjustment period. There were no differences ($P > .05$) in BW among animals fed the different diets. Goats fed the 15 % WCS diet showed higher ($P < .05$) DMI (16.2 g/kg BW) when compared to goats fed the 30 %WCS (14.0 g/kg BW) and 45% WCS (12.2 g/kg BW) diets; however, they had similar ($P > .05$) DMI than goats receiving 0% WCS (15.7 g/kg BW). Dry matter digestibility (DMD) was similar ($P > .05$) for 0 and 15% WCS diets but decreased ($P < .05$) with 30% and 45% WCS diets, mainly due to a depression ($P < .05$) in digestibility of fiber components (NDF and ADF). Ether extract digested (g/kg BW) was higher ($P < .05$) and N excreted in urine was lower ($P < .05$) for animals fed WCS. Passage kinetics associated with BGH were similar ($P > .05$) among diets. Addition of 15% WCS to the diet of these goats did not affect DMI, DMD and passage of BGH, improved EE utilization and lowered urinary N loss.

Key Words: Whole Cottonseed, Digestion and Passage, Goat

543 Broiler litter and urea-treated wheat straw as feedstuffs for Alpine doelings. G. Anmut*, R.C. Merkel², G. Abebe³, T. Sahl², and A.L. Goetsch², ¹*Alemaya University of Agriculture, Dire Dawa, Ethiopia*, ²*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*, ³*Awassa College of Agriculture, Awassa, Ethiopia*.

Thirty-two Alpine doelings (15 wk of age, 12 ± 2.05 kg) were randomly allocated to four treatments to evaluate the use of deep-stacked broiler litter (BL) and urea-treated wheat straw (UWS) as feedstuffs. In all treatments, UWS or untreated wheat straw (WS) was fed for ad libitum consumption along with a concentrate supplement fed at a prescribed percentage of BW. Treatments were: U a corn-based concentrate (1.3% N) fed at 1.5% BW with UWS (2.1% N); S a corn:soybean meal concentrate (3.2% N) fed at 1.9% BW with WS (.5% N); LL a corn:BL concentrate (2.3% N, BL at .8% BW) fed at 2.2% BW with WS; and HL a corn:BL concentrate (2.7% N, BL at 1.6% BW) fed at 3.0% BW

with WS. Animals were housed individually and fed once daily. Body weights were determined at 2-wk intervals prior to daily feeding during the 12-wk trial and ADG was calculated by regression. HL doelings consumed a greater amount of DM ($P < .05$) throughout the trial than LL, S and U animals (54.7, 45.0, 35.9, and 36.4 kg, respectively, SE = 11.64). The ADG did not vary among treatments ($P > .05$) and was 66, 63, 70, and 61 g/d (SE = 7.1) for HL, LL, S, and U, respectively. Feed efficiency was lower ($P < .05$) for HL and LL than for S doelings, whereas U doelings had a feed efficiency similar to S and LL but greater ($P < .05$) than HL (170, 145, 122, and 103 g gain/kg DMI for S, U, LL, and HL, respectively; SE = 11.6). Results indicate that both BL and UWS can be used as feedstuffs for replacement Alpine doeling growth during the early post-weaning period. The possibility of using modified crop residues and animal by-products as feedstuffs for goats is very important in countries such as Ethiopia where the availability and use of more conventional feedstuffs is limited.

Key Words: Broiler Litter, Wheat Straw, Goats

544 Intake, growth and body composition changes in Spanish and Tennessee Stiff-legged goats. C. O. Smith*, J. M. Dzakuma¹, E. Risch¹, P. M. Johnson¹, and H. D. Blackburn², ¹*Prairie View A&M University, Prairie View, TX.*, ²*USDA/ARS/National Animal Germplasm Program, Fort Collins, CO.*

The objective of this study was to perform growth curve analyses on different goat genotypes under varying nutritional regimes. Two breeds of goats, Spanish (SP) and Tennessee Stiff-legged (TS), were fed three levels (100% or *ad libitum*, 85% and 70%) of the same ration containing approximately 18% CP. These goats were classified as intermediate (SP) or small (TS) in size. They were individually penned and fed. Feed intake amounts, excreta, and bi-weekly weights were collected. After weaning at 70 d of age, 24 kids (12M,12F) from each breed were divided into three groups of 8, by sex, and put on the ration. Twenty four goats (4M, 4F from each dietary level) were slaughtered at 6 mo of age and carcass data collected. The other 24 goats were slaughtered at 12 mo of age. All weights are expressed in kilograms. Feed intake amounts, respectively, for SP and TS goats were virtually the same (51.3 and 50.5) from weaning to 6 mo, and (67.7 and 66.7) from 9 to 12 mo, even though SP breed is a heavier breed compared to TS breed. Growth weights differed ($P < .01$) for SP and TS breeds, respectively, at birth (3.2 vs 2.5) and weaning (12.8 vs 10.1); however, not at 6 mo (19.1 vs 18.6) nor 12 mo (25.8 vs 25.9). The growth weights of these breeds were fitted to the Brody (1945) growth equation, using average mature weights of 47.5 for SP and 36.8 for TS. The same maturing rate (.00268) was obtained for SP as well as TS breed. Significant differences ($P < .01$) were observed in weight of goats at the 3 dietary levels (100%, 85%, 70%) at 6 mo (21.0, 18.3, 17.2) and at 12 mo (28.5, 23.4, 25.7). Goats fed the 100% level of the diet were also heavier ($P < .05$) for SP and TS (5.3 vs 4.4), respectively, but did not differ at 12 mo (7.6 vs 7.4). Fat weights for the two breeds at 6 mo and 12 mo were not statistically significant. Sex means indicated that at 12 mo, males were heavier ($P < .01$) than females in body weight (27.9 vs 23.8) and contained more lean mass (8.3 vs 6.7); however, males deposited less fat ($P < .05$) than females (1.7 vs 2.2).

Key Words: Spanish Goat, Tennessee Stiff-legged Goat, Maturing rate

545 Effect of live weight at slaughter on goat kid meat quality. A. Arguello*, A. Marichal¹, N. Castro¹, R. Gines¹, J.L. Lopez¹, and S. Solomon², ¹*Animal Production Unit, Las Palmas de Gran Canaria University, Arucas, Las Palmas, Spain*, ²*USDA, Agricultural Research Service, Beltsville, MD.*

In Mediterranean countries live weight at slaughter (LWS) for kid goats is lower than in Arabian or African countries. Logically, increasing LWS could increase a farmer's profit margin. For that purpose, 20 twin, male Canary goat kids were slaughtered at 6 (n = 10) and 25 kg (n = 10). Carcasses were chilled (4°C) for 24 h post-slaughter at which time triiceps brachii (TB) and longissimus (LM) muscles were removed from each carcass. pH, color (L, a*, croma and hue), shear force (WBSF), water holding capacity (WHC), chemical composition (moisture, protein, fat, ash, collagen solubility), and muscle fiber morphology was measured. pH ($P < .05$), L ($P < .001$), hue ($P < .001$), WHC ($P < .001$), moisture ($P < .01$), ash ($P = .056$) and type IIA fiber percentages ($P < .05$) were less in 25 than 6 kg LWS kids. The LWS did not affect fat, collagen solubility or type I fiber percentages. The a* value ($P < .001$),

croma ($P < .01$), WBSF ($P = .089$), protein ($P < .05$), type IIB fiber populations ($P < .05$), and all three fiber type areas ($P < .05$) were higher in 25 kg LWS kids. Lean tissue from 25 kg LWS kids was darker, firmer, and drier. Few differences between LM and TB muscles were observed. Results suggest that increasing LWS (6 vs 25 kg) for kids does not have any negative effect on meat quality and would result in more kilogram of meat to be marketed.

Key Words: Meat Quality, Live Weight at Slaughter, Goat

546 Changes in Warner Bratzler shear values and mechanical strength of intramuscular connective tissue of chevon due to storage condition. G. Kannan^{*1}, C. B. Chawan², B. Kouakou¹, and S. Gelaye¹, ¹*Agricultural Research Station, Fort Valley State University, Fort Valley, Georgia*, ²*Alabama A&M University, Normal*.

Chevon (goat meat) is considered to be lower in tenderness compared to beef, pork, or lamb. The objectives of this study were to determine the effects of storage time (ST) and conditions (SC) on tenderness and changes in intramuscular connective tissue (IMCT) strength of chevon. Spanish does (8 mo of age, avg BW 25 kg) were slaughtered ($n = 12$), carcasses kept at 4°C for 24 h, and then fabricated into 2.5 cm-thick leg, arm, and loin/rib cuts. The cuts from six carcasses were vacuum packed and wet aged at 2°C for 0, 4, 8, or 12 d. To assess the influence of oxidation on postmortem tenderization, the cuts from the remaining six carcasses were placed on styrofoam trays, wrapped with polyvinyl-chloride film, and stored at 2°C for similar periods. At each ST, longissimus dorsi (LD), semimembranosus (SM), and triceps brachii (TB) muscles were assessed for Warner Bratzler shear (WBS) values. The IMCT samples were prepared by treating LD tissues in NaOH solution and then embedding in an acrylamide solution. The NaOH-treated samples were prepared for scanning electron microscopy (SEM) using standard dehydration protocol, followed by freeze-drying and gold-coating. Intact perimysium and honeycomb structures of endomysium with no muscle fiber elements were observable under SEM. Neither SC nor ST influenced the mechanical strength of IMCT preparations, as measured by a texture analyzer, although raw LD shear values decreased over time. Cooked meat WBS values in both SC were different ($P < .01$) for the three muscles studied, with the values high in SM, low in LD, and intermediate in TB. The WBS values were also higher ($P < .01$) at 0 h than at other ST. However, there was no SC x ST interaction to indicate any adverse influence of oxidation on tenderization of chevon. The results suggest that IMCT may be a major factor contributing to chevon toughness.

Key Words: Chevon, Aging, Tenderness

547 Manipulation for out of season breeding in Spanish goats. T. Wuliji^{*1}, A.L. Goetsch¹, A. Litherland², T. Sahl¹, R. Puchala¹, and L.J. Dawson¹, ¹*E (Kika) de la Garza Institute for Goat Research, Langston University, OK*, ²*AgResearch Grasslands, Private Bag, Palmerston North, New Zealand*.

The manipulation of seasonal breeding in goats could improve profitability of meat goat production by producing out-of-season meat kids for Christmas festive markets and increasing the number of kids born per female. Therefore, the objective of this experiment was to evaluate

means of manipulating the breeding season. Three Spanish bucks were conditioned for 2 mo of long-day photoperiod (16 h light:8 h dark) starting January 19, 1999, followed by a single dose of a continuous-release melatonin implant (18 mg, Regulin, Schering Pty. Ltd). Eighty Spanish does (15 two years of age and 65 yearling doelings) were allotted to three treatments of zero, melatonin implant, or oral administration of melatonin (Sigma Chemical Co., St. Louis, MO). Half of each melatonin group also received three pellets of bromocryptine mesylate (215 mg) implants (Innovative Research of America, Sarasota, FL). Therefore, treatments were: control (C), melatonin implant (MI), melatonin and bromocryptine mesylate implants (MIB), melatonin oral delivery (MO, 3 mg/d), and melatonin oral delivery and bromocryptine mesylate implant (MOB). At the end of the treatment period (April 13), does were randomized and bred in three single-sire groups for two estrus cycles (34 d). The number of does bred was 14, 14, 14, 14, and 15; number of does pregnant at ultrasonographic scanning was 5, 10, 12, 12, and 11; number of does kidded was 5, 10, 11, 8, and 8; and number of kids born was 8, 18, 18, 13, and 18 for C, MI, MIB, MO, and MOB, respectively. There was no difference among treatments in number of does bred, whereas the melatonin-treated groups had a greater ($P < .05$) number of does that kidded and number of kids born than the control. In conclusion, melatonin regardless of delivery mode increased the number of does kidding in the late summer/early fall.

Key Words: Goat, Melatonin, Breeding

548 Effects of physiological status and energy intake on cortisol, thyroid hormones and blood metabolites in dairy goats. B. Kouakou^{*1}, S. Gelaye¹, O.S. Gazal², G. Kannan¹, T.H. Terrill¹, and E.A. Amoah¹, ¹*Agricultural Research Station, Fort Valley State University, GA*, ²*Department of Biological Sciences, Saint Cloud State University, MN*.

Yearling does (BW = 42 ± 6.4 kg; $n = 10$) were used in a completely randomized design experiment to determine the effects of physiological status (non-pregnant vs pregnant) and energy intake on serum cortisol, triiodothyronine (T₃) and thyroxine (T₄), non-esterified fatty acid (NEFA), and blood urea nitrogen (BUN). Animals were stratified by BW then randomly assigned to be individually fed a 16% CP diet (2.9 MCal DE/kg DM) at either maintenance (M) or twice maintenance level (2M) for 21 d. Animals were weighed and blood samples taken weekly. At the end of this non-pregnant period, animals were pen-fed the station basal diet of concentrate and hay, their estrous cycles were synchronized using a standard luteal regimen, and they were bred to a single buck within 48 h after the last injection. On d 42 post breeding, pregnancy was determined in all does by progesterone assay (100% pregnancy rate). On d 43 of pregnancy, the does were weighed and put back on experiment under similar pre-breeding conditions. Serum samples were assayed for cortisol, T₃ and T₄, BUN, and NEFA. Overall, cortisol level was lower ($P < .005$) with maintenance intake. Dietary treatment did not affect ($P > .10$) thyroid hormones. Blood urea nitrogen was higher ($P < .001$) for M relative to 2M-fed does regardless of physiological status. Levels of NEFA were greater ($P < .001$) in M-fed than 2M-fed animals. Within the M-fed, the non-pregnant had higher ($P < .05$) NEFA than the pregnant does. However, NEFA concentrations were similar among the 2M-fed goats regardless of physiological status.

Key Words: Goats, Hormones, Metabolites, Intake Level

GRADUATE STUDENT PAPER COMPETITION ADSA NORTHEAST BRANCH - ASAS NORTHEAST SECTION

549 Growth hormone (GH) response to growth hormone-releasing hormone (GHRH) in beef cows divergently selected for milk production. T.L. Auchtung^{*1}, D.S. Buchanan², C.A. Lents², S.M. Barao¹, and G.E. Dahl¹, ¹*University of Maryland, College Park*, ²*Oklahoma Agricultural Experiment Station, Stillwater*.

In dairy cattle, increased circulating growth hormone has been associated with selection for greater milk yield. This study tested the hypothesis that beef cows divergently selected for milk production would have differing GH responses to a challenge dose of GHRH. GH response to a challenge of GHRH was measured in 36 Angus sired cows ranging from 2 to 10 yr of age. The cows were classified as HIGH ($n=20$) or LOW

($n=16$), on the basis of their sires' Milk EPD. Mean Milk EPDs (kg) were 16.6 and -14.4 for HIGH and LOW, respectively. Mean BW (kg ± SD) was 592 ± 61 and 607 ± 43 for HIGH and LOW cows, respectively. Blood samples were taken immediately prior to and 10 min following a clearance dose of 4.5 µg GHRH/100 kg BW (injected i.v.) and, 3 hr later, immediately prior to and 10 min following a challenge dose of either 1.5 or 4.5 µg GHRH/100 kg BW. Each animal received both challenge doses; the doses were randomly assigned across the 2 d of blood collection. The GHRH was a bovine analog (1-30) GHRH. Concentrations of GH and IGF-1 in serum were measured by RIA. IGF-1 was measured in the baseline blood sample on Day 1. A positive relationship ($r = .35$, $P < .03$) was found between the cows' rankings for each dose of GHRH, i.e. high responders to the low dose were high responders to the

high dose. Milk EPDs of the sires were positively related to the 4.5 μg /100 kg BW challenge dose of GHRH ($R^2 = .10$, $P < .03$) in a model that included both HIGH and LOW cows. Sire Milk EPDs tended ($P < .08$) to be related to the 1.5 μg GHRH/100 kg BW challenge dose in a model that included only HIGH cows. In addition, Milk EPDs were inversely related to IGF-1 concentrations of HIGH cows. Growth hormone response to GHRH challenge has potential as an additional tool in selection for higher milk production in beef cattle. Studies are underway to evaluate the relationship of GH response to GHRH at weaning and subsequent milk production in beef females.

Key Words: Beef Cattle, Milk Production, Growth Hormone

550 Effect of age and equine somatotropin treatment on immune function in female horses. P.D. Guirnalda*, V. Roegner, and K. Malinowski, *Rutgers-The State University of New Jersey, New Brunswick.*

Aging has been associated with declines in somatotropin and IGF-I levels as well as various parameters of immune function. In order to determine whether ST administration could reverse immunosenescence in horses, 8 young and 8 aged female Standardbred horses were given 10mg/d recombinant equine somatotropin (eST) or vehicle for 49 d. IGF-I was elevated in ST-treated mares ($P < 0.0001$). Monocyte and lymphocyte number tended to be lower in ST-treated mares ($P < 0.07$). Aged mares treated with ST demonstrated lower granulocyte number ($P < 0.05$) and CD8+ lymphocyte counts were higher in young mares ($P < 0.01$) resulting in a higher CD4:CD8 ratio in aged mares. There was a trend towards lower mitogen induced T and B lymphocyte proliferative response in aged mares (ConA, PHA, PWM; $P = 0.17, 0.17, \text{ and } 0.13$, respectively). ST treatment resulted in a reduced primary antibody response in aged mares compared to vehicle-treated and ST-treated young mares ($P < 0.05$). Young ST-treated mares displayed a higher primary antibody response compared to all other treatment groups ($P < 0.05$). Horses are similar to other species in that they exhibit similar signs of age-related declines in immune function which were not reversible with ST treatment.

Key Words: Horses, Aging, Somatotropin

551 Age related changes of somatotropin, insulin-like growth factor-I and insulin-like growth factor binding protein-2 and -3 in male and female Hereford calves. K.E. Govoni*¹, T.A. Hoagland¹, and S.A. Zinn¹, ¹*Department of Animal Science, University of Connecticut, Storrs 06269.*

The overall objective of this study was to examine the ontogeny of the somatotropic axis in male (M) and female (F) beef cattle from birth to nine months of age. To meet this objective, eight M and eight F Hereford calves were used and all animals were managed similarly. Briefly beginning at two weeks of age, calves were moved onto grass pasture with dams and weaned at 207d of age. Following weaning, calves were moved to pens and fed a corn silage based diet with 42% concentrate top dress (1kg/calf) formulated for calves to gain 1.2 kg/day. Blood serum samples, collected by venipuncture of a jugular vein, and body weights (BW) were taken weekly. Somatotropin (ST) and Insulin-like Growth Factor-I (IGF) were analyzed by RIA. IGF Binding Protein (BP) -2 and -3 were quantified by Western Ligand Blot and data were expressed as a percent of standard BP-3 density. To date, 75% of the data have been collected and analyzed. Averaged across all samples (41 samples/animal), serum concentrations of ST were greater in M (20.7 ng/mL) than F (9.5 ng/mL) through 277d of age. From birth to 277d of age, serum ST decreased in M (23 to 20 ng/mL; $p < .05$) and F (32.8 to 4.4 ng/mL; $p < .01$). In males, IGF increased from birth to 186d of age (42.1 to 164.5 ng/mL; $p < .01$), but not in F (95.3 to 107.5 ng/mL; $p = .6$). From birth to 165d of age, BP-3 increased in M (75 to 152%; $p < .01$) and F (85 to 134%; $p < 0.01$). However, BP-2 increased in F (81 to 139%; $p < 0.05$), but not in M (88 to 105%; $p > 0.1$) in the same time frame. Growth rates of M and F were equal from birth to 109d of age, but M grew 8% faster than F from 109 to 291d of age. In conclusion, there are changes with age in several characteristics of the somatotropic axis and these changes are different between M and F.

Key Words: Calf, Somatotropic Axis, Growth

552 Effects of prepartum somatotropin and/or monensin on periparturient metabolism and production. J. E. Vallimont*¹, G. A. Varga¹, A. Arieli², and T. W. Cassidy¹, ¹*Pennsylvania State University, University Park,* ²*Hebrew University of Jerusalem, Israel.*

Fifty-five multiparous Holstein cattle were used to evaluate the effects of increasing glucose precursors during the late dry period on postpartum health and production. Treatments were TMR topdressed with 300 mg monensin/day (M), $n = 15$; injection of exogenous somatotropin (ST), $n = 14$; monensin and somatotropin in combination (ST+M), $n = 13$; or no supplement (C), $n = 13$ during the last 28 days prior to expected parturition. A 500 mg subcutaneous injection of somatotropin (POSILAC[®]) was administered in the tail head at d -28 and -14 relative to expected calving. Cows ($n = 8$) not expected to calve within 48 hours of their due date were given a third somatotropin injection. The prepartum diet contained 14.5% crude protein and 1.6 Mcal/kg NEL, both on a DM basis. Diet and management were the same for all cattle after parturition. Production and intake were measured daily until 63 days in milk. Milk composition, blood metabolites, and body weight and condition score were measured weekly. Cows in the ST group consumed 1.2 kg more DM in the prepartum period than all other groups ($P < 0.05$). Prepartum NEFA levels were higher ($P < 0.05$) in the C group than the ST and ST+M groups (159.8 $\mu\text{eq/L}$ vs. 126.2 $\mu\text{eq/L}$ and 123.8 $\mu\text{eq/L}$, respectively). Postpartum results are presented in the table. M and ST treatments significantly increased milk production over C. Prepartum M treatment resulted in lower plasma NEFA postpartum. Results from this study indicate that prepartum treatment with monensin reduces adipose tissue mobilization and improves milk production of the periparturient dairy cow.

Treatment	Postpartum				SEM
	C	ST	M	ST+M	
DMI/ kg/d	21.75 ^a	22.75 ^b	23.78 ^c	22.94 ^b	0.48
Milk Yield, kg/d	44.28 ^a	45.23 ^b	46.22 ^c	45.05 ^{ab}	0.91
Fat yield, kg/d	1.68	1.66	1.68	1.62	0.04
Protein yield, kg/d	1.34 ^a	1.37	1.40 ^b	1.38	0.03
NEFA, $\mu\text{eq/L}$ ¹	408.0 ^a	380.7	330.8 ^b	347.0	28.09

^{abc} Means in a row without common superscripts differ ($P < 0.05$) according to Student-Newman-Keuls Test. ¹ NEFA average for first 3 weeks in lactation.

Key Words: Transition cow, Somatotropin, Monensin

553 Effect of a short-term treatment with a Controlled Internal Drug Releasing (CIDR) device and Follistimulating Hormone (FSH) on induction of estrus and lambing rates in anestrus ewes. M. Knights*, T. D. Maze, P. E. Lewis, and E. K. Inskeep, *West Virginia University, Morgantown.*

Objectives of this study were to evaluate, in anestrus ewes, effectiveness of: 1) a CIDR device (.3 g progesterone, P₄) administered for 5 d to induce estrus, and 2) FSH (Folltropin; 55 mg NIH-FSH-P1 equivalent) in propylene glycol 24 h before insert removal (d 0), to increase ovulation rate and prolificacy. Crossbred ewes on 7 farms were assigned at random to 3 treatments, control (C; $n = 125$), 5 d P₄ (P₅; $n = 257$) and 5 d + FSH (P₅F; $n = 271$). Raddled rams were joined at insert removal and ewes were observed for 3 d to detect estrus. On d 14, ovulation rates (OR) of all ewes detected in estrus were determined using transrectal ultrasonography. On d 26-30, rams were removed and ewes were examined for pregnancy to the first service period. Ewes were reexamined 20-25 d later to detect conception at the second service period. Percentage of ewes detected in estrus was higher in P₄-treated (76%) than in C (20%; $P < .0001$) but did not differ due to FSH in P₄-treated ewes. Mean OR (1.95 \pm .04) did not differ due to FSH. Mean conception rate (CR; 66.5%) and pregnancy rate (PR; 42%) to the first service period were higher in P₄-treated ewes ($P < .001$) than in C (0%), but did not differ due to FSH in P₄-treated ewes. Overall pregnancy rates based on examination at d 46-55 and on number of ewes lambing (70 and 61.4%) were higher in ewes receiving P₄ (73 \pm 1 and 65.3 \pm 1%; $P < .001$), than in C ewes (56.8 \pm 4 and 44.8 \pm 4%), but did not differ between ewes receiving P₄ only (P₅; 71.6 \pm 3 and 63.4 \pm 3%), and ewes receiving P₄ and FSH (P₅F; 74.5 \pm 3 and 67.2 \pm 3%). Prolificacy to the first service period and overall did not differ among treatments (0 and 1.5 \pm .1; 1.5 \pm .1, and 1.5 \pm .1; and, 1.6 \pm .1 and 1.6 \pm .1 for C, P₅ and P₅F groups, respectively). Mean lambing rates (.7 \pm .1, 1.0 \pm .1, and 1.1 \pm .1 lambs born per ewe exposed for C, P₅ and P₅F, respectively)

were higher in P₄-treated ewes (P < .001), and tended to be higher (P = .09) in FSH-treated ewes than in ewes treated with P₄ alone. A 5-d treatment of anestrus ewes with P₄ induced estrus, increased the PR to two service periods (20 percentage points), and the lambing rate (0.3). FSH at the dosage and time used did not increase OR.

Key Words: CIDR, Anestrus Ewes, Lambing Rates

554 Comparison of energy parameters in Jersey and Holstein dairy cows in early lactation. R. R. Rastani* and S. M. Andrew, *University of Connecticut, Storrs, CT.*

The objective of the study was to evaluate the effect of breed on the rate and extent of energy mobilization in early lactation. Nine Jersey and nine Holstein dairy cows were paired by breed, parity, and calving date. Cows were individually fed a total mixed ration, ad libitum, from parturition through 120 DIM. The total mixed ration was comprised of 37 % corn silage, 13 % grass silage, and 50 % concentrate on a dry matter basis. Feed intake and milk production were measured daily; BW and milk composition were measured every two weeks. Energy balance was calculated utilizing 1989 NRC equations. Holsteins had a higher daily milk production compared to that of Jerseys, 44.9 kg and 26.6 kg, respectively (P < 0.01). Milk fat and protein composition were higher for Jerseys relative to the milk composition of Holsteins (P < 0.01). Average BW was 462 kg for Jerseys and 683 kg for Holsteins. Net energy intake was higher for Holsteins compared to that of Jerseys, 37.8 Mcal/d and 28.2 Mcal/d, respectively. Milk energy was 21.2 Mcal/d and 30.5 Mcal/d, for Jerseys and Holsteins, respectively (P < 0.01). Energy balance differed between breeds through the seventh week of lactation (P < 0.05). Jerseys remained in negative energy balance for a shorter period of time and to a lesser extent relative to Holsteins. The energy balance nadir was -6.19 Mcal/d for Jerseys and -12.9 Mcal/d for Holsteins. Expressed as a proportion of metabolic BW (BW^{0.75}), net energy intake did not differ between breeds; however, milk energy was higher for Holsteins compared to Jerseys when adjusted to metabolic BW. This resulted in a higher calculated energy balance for Jerseys during early lactation.

Key Words: energy balance, Jersey, early lactation

555 The effect of urea calcium chloride fertilization on yield and nutrient composition of cool-season forage grasses for prepartum dairy cows. K.M. Danahey^{1,2}, E.D. Thomas², J.R. Knapp¹, C.S. Ballard², and C.J. Sniffen², ¹*University of Vermont, Burlington*, ²*W.H. Miner Institute, Chazy, NY.*

The objective of this research was to examine the effects of nitrogen (N) and chloride (Cl) fertilizers in the production of cool-season forage grasses for prepartum dairy cows. "Palaton" reed canarygrass was fertilized in two consecutive trials, April 1998 and again in April 1999. Four fertilizer treatments: {unfertilized control; 22.7 kg of Cl as urea calcium chloride (8-0-0-25 Ca-44 Cl); 45.4 kg N as ammonium nitrate (33.5-0-0); and combined 45.4 kg NH₄NO₃ plus 22.7 kg NH₄CaCl₂} were randomly assigned within four plots following a split-plot design. A second application of 45.4 kg of N was applied immediately after first harvest to the treatments that received it initially. There was no second application of NH₄CaCl₂. Two cuttings were harvested each year at approximately 20% bud stage from a 0.92 m x 0.32 m section of each treatment block to determine yield, DM and nutrient composition. Data were analyzed using a split-split plot design. Growing conditions were wet in 1998 and dry in 1999. In both 1998 and 1999, application of N fertilizer increased forage yield for both harvests (p<0.05). The application of Cl had no effect on yield (p>0.05). Application of N fertilizer decreased forage Cl concentration significantly (p<0.05). Alternatively, forage Cl concentration was significantly increased nearly three-fold across all harvests when Cl fertilizer was applied (p<0.01). Dietary cation-anion (DCAD) levels were significantly decreased from 383 to 194 for 1st cut and 293 to 118 for 2nd cut when Cl fertilizer was applied (p<0.05). It is evident from this study that the application of NH₄CaCl₂ has the potential to increase DM yield and Cl concentration of the forage. The high Cl forage is beneficial in decreasing the DCAD used to balance prepartum rations and may reduce or eliminate the use of commercial anionic salts.

Key Words: Chloride, DCAD, Forage

556 Supplementing Natuphos with an *Escherichia coli* phytase expressed in yeast improves its in vitro and in vivo efficacy. C.H. Stahl*, K.R. Roneker, T. Xiang, J.R. Thornton, and X.G. Lei, *Cornell University, Ithaca, NY.*

We have expressed an *E. coli* phytase (EP) gene in a yeast system and the secreted glycoprotein exhibited distinct differences in pH optimum, resistance to proteolysis, and substrate specificity from those of Natuphos, a recombinant *Aspergillus niger* phyA phytase (AP). The objective of this study was to determine the in vitro and in vivo efficacy of EP and AP supplemented alone or in combination on phytate-phosphorus hydrolysis. In the in vitro experiment, 0.6 units of EP, AP, or a 1:1 combination of EP+AP were mixed with 2 g soybean meal that was suspended in 10 ml of 0.2 M citrate buffer, pH 3.5, and incubated at 37 C for 1 h. There was 146% and 26% more phosphorus (P < 0.01) in the supernatant released by the EP than that by the AP and the AP+EP, respectively. Incubating soybean meal with the AP+EP released 95% more phosphorus (P < 0.01) than the AP alone. Apparently, the combination of these two phytases was more effective than the AP alone, but showed no benefit over the EP alone. In the in vivo experiment, 42 pigs (6-wk old) were fed a corn-soybean meal, low-phosphorus basal diet supplemented with AP, EP, or AP+EP at 500 U/kg of diet for 6 wk. Although there were no significant differences in overall ADG, ADFI, or gain:feed among treatment groups, pigs fed the EP had higher (P < 0.05) plasma inorganic phosphorus concentrations and lower (P < 0.05) plasma alkaline phosphatase activities than those of pigs fed the AP at wk 4. Pigs fed the AP+EP were not significantly different from either of the other two treatment groups. Just as in the in vitro study, EP seemed to be more effective in releasing phytate-phosphorus from the corn-soy diet for pigs than AP. In conclusion, the biochemical differences between these two enzymes may offer us an innovative approach to enhance the activity efficacy of Natuphos phytase.

Key Words: Phytase, Pigs, Phosphorus

557 Replacement value of wet microbrewery grains in swine finishing diets. B.A. Altizio*, J.E. Wohlt, P.A. Schoknecht, and M.L. Westendorf, *Cook College, Rutgers University, New Brunswick, NJ.*

Previous reports have indicated that commercially produced brewers' grains have replacement value in corn/soybean diets fed to swine. Spent microbrewery grains contain less CP than commercial grains (21 vs. 25%). Thus, it is unknown if grains from microbreweries can provide the same results as commercially produced varieties. Therefore a feeding study was conducted with wet microbrewery grains (25% of diet DM) replacing corn, (23% of diet DM) and soybean meal (44% of diet DM) in swine finisher diets. Thirty-six hogs (40.5 kg ± 1.9; mean ± SEM) were blocked by sex and weight and fed one of three dietary treatments; corn/soybean meal (CS), corn/soybean meal/soy hulls (CSH), or corn/soybean meal/wet brewers' grains (WBG) for 10 wk. Diets varied in DM (CS, CSH 89%, WBG 55%), but were isonitrogenous (16% CP). Diets CSH and WBG contained similar ADF (7.3%, DM basis), higher than the CS diet (3.3%, DM basis) with energy content ranging from 3.1 to 3.3 Mcal/kg. Upon completion of the feeding trial, all hogs were slaughtered and carcass measurements collected. In the statistical model, effect of diet on performance and carcass measurements was evaluated by pen (n=4). Hogs fed CS, CSH, and WBG had similar DMI (3.0, 3.6, 3.0 kg/d, p=0.36); ADG (0.920, 0.943, 0.833 kg/d, p=0.07), and feed:gain (3.3, 3.6, 3.6, p=0.15); respectively. The higher moisture content of WBG did not limit feed intake or performance. Hogs fed CS, CSH, and WBG also produced similar carcass (74.8, 75.2, 68.7 kg, p=0.09), backfat (27.9, 28.7, 25.8 mm, p=0.38), ham (14.3, 14.5, 13.5 kg, p=0.18), and loin (13.6, 13.6, 12.7 kg, p=0.25); respectively. Even though diets had similar ADF and CP, hogs fed WBG tended to produce lighter, leaner, carcasses compared to those fed CSH. These data suggest that WBG from microbreweries can be used to replace a portion of the corn and soybean meal in finisher swine diets potentially decreasing feed costs.

Key Words: Wet microbrewery grains, Finisher pigs, Performance carcass merit

558 Effect of trough-anchored blind teats on production and welfare of early-weaned piglets, fed a liquid or pelleted diet. J.A. Rau* and I.J.H. Duncan, *University of Guelph, Colonel K.L. Campbell Centre for the Study of Animal Welfare, Guelph, Canada.*

A 2x2 factorial design was used to determine the effect of trough-anchored blind teats on food intake, water use, growth, and skin condition of piglets weaned at 14 days, fed a liquid or pelleted diet. 192 pure-bred Yorkshire piglets made up 4 treatments, with 6 replicates per treatment, 8 piglets per replicate, or pen, and pen as the experimental unit. All piglets were fed a commercial early wean diet from a trough with or without blind teats anchored to the lumen, for a period of 14 days immediately following weaning (Phase 1). At 14 days post-weaning experimental treatments were removed and all piglets were fed a commercial starter diet, ad libitum, from conventional food troughs for an additional 14 days (Phase 2). Measurements of food intake, water use

(from nipple drinkers), body weight, and skin condition of piglets were taken over the first 28 days post-weaning. Trough-anchored blind teats significantly reduced the severity of skin lesions, thought to be a result of severe belly-nosing, on the bellies and flanks of piglets in both Phase 1 ($P < 0.005$) and Phase 2 ($P < 0.0001$). Feeding a diet in liquid form resulted in less water use over the 28 day trial ($P < 0.005$), reduced the severity of skin lesions over Phase 1 ($P < 0.05$) and Phase 2 ($P < 0.0001$), and increased apparent dry matter intake ($P < 0.0001$) and average daily gain ($P < 0.01$) over Phase 1. These results suggest that there may be a critical period in which the development of misdirected massaging and sucking by early-weaned piglets becomes established. Directing the performance of the early-weaned piglet's innate sucking behaviour towards blind teats and liquid food curbs the development of misdirected massaging and sucking, and improves food intake immediately following weaning, resulting in overall improved piglet production and welfare.

Key Words: Feeding, Piglets, Welfare

GRADUATE STUDENT PAPER COMPETITION ADSA DAIRY FOODS DIVISION

559 Bioavailability of vitamin A provided as a β -lactoglobulin Complex. J. J. Shaw*, J. C. Allen, and H. Swaisgood, *North Carolina State University, Raleigh.*

Fluid milk products have been fortified with vitamin A (along with Vitamin D) since the 1930s to reduce the incidence of disorders caused by fat-soluble vitamin deficiency in the USA. However, non-fat or low-fat milk products often do not comply with nutrition labeling requirements, possibly because the vitamin adheres to packaging or processing equipment. Because vitamin A, a fat-soluble nutrient, will bind with β -lactoglobulin, a major component of bovine milk, we propose that β -lactoglobulin can be used as a carrier to fortify skim milk. We tested bioavailability of this complex from skim milk and an aqueous solution and compared the bioavailability with an oil-based vitamin A vehicle. Rats were fed vitamin A deficient or control diets for 10 wk. During the last 4 wk, deficient rats were repleted by oral gavage with the 4 test treatments. At 6 wk, serum vitamin A was $2.3 \pm 5 \mu\text{g/dl}$ in deficient rats vs. 15.3 ± 2.6 in controls. At 10 wk, serum vitamin A was 24.7 ± 6.5 in control and 12.6 ± 2.0 , 14.8 ± 3.7 , 3.3 ± 0.8 , 6.2 ± 0.9 in rats repleted with vitamin A in oil, vitamin-A- β -lactoglobulin complex, vitamin A in oil added milk, and vitamin-A- β -lactoglobulin complex added milk, respectively. Thus, β -lactoglobulin complexes had bioavailability as good as or better than an oil-based fortifier. Skim milk reduced the bioavailability of both forms.

Key Words: Vitamin A, β -lactoglobulin, Bioavailability

560 Impact of low concentration factor (CF) microfiltration (MF) on the composition and aging of Cheddar cheese. M. Neocleous*, D.M. Barbano, and M.A. Rudan, *Northeast Dairy Foods Research Center, Cornell University, Ithaca, NY.*

Raw skim milk was microfiltered twofold (2X) using a $0.1 \mu\text{m}$ ceramic membrane at 50°C . The average true protein content of the retentate and permeate across the four trials of cheese making was 5.31 and 0.53%, respectively. Cream and MF permeate were added back to the 2X skim retentate to achieve a constant casein to fat ratio of 0.68. Four cheeses were made from 1X (control), 1.3, 1.6 and 2X CF cheese milks in a 4x4 randomized block design on four different days from different batches of milk. Double strength rennet (Chymax) was used at a rate of 0.099 ml/kg of milk for the control and 80, 60 and 33% of this rate was used for the 1.3, 1.6 and 2X CF, respectively. A constant amount of starter was used per original volume of unconcentrated milk for all treatments. The 1, 1.3, 1.6 and 2X cheeses had moisture 35.3, 34.6, 34.4, 33.8%, protein 24.9, 25.1, 25.2, 25.7%, fat 34.5, 34.8, 34.8, 34.8%, pH 5.10, 5.12, 5.13, 5.16, calcium 0.77, 0.81, 0.82, 0.85%, and TPA Hardness 61.2, 65.7, 71.4, 75.0 Newtons, respectively. Cheese moisture decreased and protein, salt in moisture, initial pH, calcium and TPA hardness increased with increasing CF. The pH 4.6 and 12% TCA soluble nitrogen content of the cheese increased during 180 days of aging, but was significantly lower with increasing CF. The reduced rate of proteolysis with increasing CF could have been caused by one of the following: lower moisture, higher calcium or calcium to protein ratio, too little rennet added, or some other factor. A 2 x 3 paired comparison (control vs. 2X) follow up trial

was done to identify the cause of the reduced rate of proteolysis. The make procedure was adjusted for the 2X treatment to increase cheese moisture and the rennet addition was increased from 33% to 48% of the control. The cheeses are currently aging.

Key Words: Microfiltration, Cheddar cheese, Proteolysis

561 Response of bifidobacteria to acid adaptation. V. Deibel* and J. Steele, *University of Wisconsin, Madison.*

Response of Bifidobacteria to acid adaptation
Probiotics, including Bifidobacteria, play a role in lowering the pH of the large intestine which restricts growth of pathogens and are believed to have other benefits that promote human health. Cell viability during gastrointestinal passage must be maintained to assure probiotic efficacy. The gastrointestinal tract presents stress conditions that include stomach acidity reaching a pH of 1.5. Contents can remain in the stomach for up to 140 minutes. Acid survival mechanisms were studied in two commercial strains and three human isolates of Bifidobacteria. Acid adaptive responses were induced by exposure to pH 4 for 10, 20 or 120 minutes after growth in batch cultures at a constant pH of 6.5. After exposure to pH 4, the pH was lowered to pH 2.0 for 140 minutes (acid challenge). Two of the three human isolates (*B. longum* JBL 3301 and JBL 3324) and the two commercial strains (*B. longum* and *B. lactis*) were able to survive exposure to pH 4.0 for 10 minutes without significant ($P > 0.05$) loss of viability. The other human isolate (*B. longum* JBL3300), showed a 2 log decrease in CFU/ml after acid adaptation. Strains were tested for the ability to survive acid challenge with and without prior acid adaptation. The commercial strains were unable to survive acid challenge without acid adaptation but with acid adaptation 10^4 CFU/ml survived. The human isolates were unable to survive acid challenge with or without acid adaptation. To determine if changes occur in the fatty acid composition of the cellular membrane in response to pH changes, the cellular membrane fatty acid profiles were examined in a commercial strain and human isolate (both *B. longum*). Cells were grown at pH 4.5, 5.0, 5.5 and 6.5 with and without acid adaptation. Cellular membrane fatty acid profiles for n14:0, n16:0, n18:0, n18:1 and 19:0 revealed significant changes ($P < 0.05$). These data suggested that the cell membrane fatty acid composition may play a role in the acid tolerance response of Bifidobacteria and that membrane fatty acid profiles are altered within 10 minutes after acid adaptation.

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Key Words: Probiotics, Bifidobacteria, Cell membrane fatty acids

562 Survival of acid adapted and non-acid adapted enterohemorrhagic *Escherichia coli* O157:H7 during the manufacturing and curing of reduced-fat Cheddar cheese. P. Kaothien* and D.R. Henning, *Minnesota-South Dakota Dairy Foods Research Center, South Dakota State University, Brookings.*

The objective of this study was to compare the ability of acid adapted and non-acid adapted *Escherichia coli* O157:H7 to survive in reduced-fat Cheddar cheese manufacturing process and curing. Two treatments,

each consisting of six replications, were designed utilizing a cocktail of three strains of *E. coli* O157:H7. *E. coli* O157:H7 cocktail was adapted to acid by culturing for six hours at pH 5.0. Reduced-fat cheddar cheese was made by 33% fat reduction method using active lactic mesophilic starter culture. The target for both treatments was 5,000 to 50,000 CFU/ml. Samples were taken during cheese manufacturing and 1, 2, 3, 7, 14, 30, and 60 days of curing at 6 to 7°C. Samples were grated, stomached with 2% sodium citrate, serially diluted and spread plated on MacConkey Sorbital Agar and incubated at 37°C for 24 hours. Typical colorless colonies were counted as *E. coli* O157:H7. The results from both treatments indicate that *E. coli* O157:H7 can grow during reduced-fat Cheddar cheese manufacturing and can survive 60 days of curing with less than two log reduction in populations at 2.93 to 4.65% salt in moisture phase (SMP). And also no significantly difference between survival of acid adapted and non-acid adapted populations ($P > 0.05$).

Key Words: Reduced-fat Cheddar cheese, Acid adapted, Cheese curing

563 Application of chemometrics to sensory, analytical and gas chromatography olfactometry data of Ragusano Cheese from milk from pasture and TMR fed cattle. S. Carpino^{1,2}, D.M. Barbano¹, T.E. Acree¹, G. Licitra², and K.J. Siebert¹, ¹Cornell University Ithaca, N.Y.USA, ²Consorzio Ricerca Filiera Lattiero-Casearia, Ragusa, Italy.

The objectives of this work were to determine the effect of cattle feed on cheese quality and to determine relationships between cheese sensory and chemical analysis. Milk was collected from pasture and Total Mix Ration (TMR) fed cattle. The Ragusano cheeses were produced from the two milk sources in duplicate, replicated four times and were subjected to chemical analysis, conventional sensory testing and gas chromatography olfactometry (GCO). Each block of results was examined by Exploratory Data Analysis (Principal Components and Factor Analysis) and by pattern recognition (SIMCA) to see if it contained sufficient information for classification into pasture fed and TMR fed groups. The data was also examined to see if relationships between the analytical and sensory results could be elucidated with the modeling technique Partial Least Squares Regression (PLS). Factor analysis revealed that the 26 sensory, 7 chemical analysis and 11 GCO data represented 9, 3, and 6 fundamentally different phenomena, respectively. The SIMCA procedure was able to correctly classify the cheese samples as to the type of feed using either the sensory data or chemical analysis data. Five of the nine conventional sensory odor descriptors ("butyric odor", "toasted", "almond", "floral" and "butter") were successfully modeled from the GCO data ($R^2 \geq 0.66$). Three of the eight taste descriptors ("acid", "bitter" and "butyric taste") were successfully modeled from the GCO data ($R^2 \geq 0.79$). Two of the consistency descriptors ("smooth" and "fracture") and one of the mouth structure descriptors ("teeth stickiness") also led to good models with GCO data ($R^2 \geq 0.70$). This chemometric application clearly indicate that there are significant differences between the cheeses made from milk from pasture fed and TMR fed cattle that are perceptible to a taste panel and from chemical analysis. It was possible to relate a number of sensory odor, taste and other characteristics to the GCO results.

Key Words: Chemometric, Cheese, Feed

564 Characterization of a novel phage resistance mechanism in *Lactococcus lactis*. J. D. Bouchard*, E. Dion, and S. Moineau, *Universite Laval, Quebec, Canada*.

It is well documented that milk fermentation can be slowed down by lytic bacteriophages. Studies on phage-host interactions led to the discovery of natural lactococcal plasmids coding for anti-phage activities. The transfer of these plasmids into phage-sensitive industrial strains constituted an important milestone in the late 80s. Several constructed cultures were successfully used for a decade in commercial large-scale fermentations. However, new phages have emerged. Thus, it is necessary to find novel anti-phage mechanisms. Here, we report the isolation and characterization of a new lactococcal anti-phage system encoded on a 12.2-kb plasmid, named pED1. This mechanism confers resistance against phages of the 936 and the P335 species but not against the c2-like phages. Phage p2 (936 species) had an efficiency of plaquing (EOP) of 9.5×10^{-6} , a 15-fold diminution of its efficiency to form centers of infection (ECOI), and a 10-fold reduction of its burst size. Phage ul36 (P335 species) was similarly affected with an EOP of 3.0×10^{-7} , a 18-fold

decrease of the ECOI and a 12-fold reduction of the burst size. Phage adsorption and cell survival following phage infection were unaffected by the mechanism, indicating the presence of an abortive infection system (Abi). A 2.2-kb fragment containing four open reading frames (ORFs) conferred the phage resistance phenotype. Inactivation of two of these ORFs (127 and 213 amino acids) resulted in the loss of the phenotype. The products of these putative genes had no homology with proteins in the databases and their G+C content was 31.9%. Phages p2 and ul36 DNA was detected in Abi⁺ cells, but only in its immature forms. Phage mutants insensitive to the Abi were isolated in laboratory. Mutants of ul36 had different restriction profiles and restriction mapping revealed that all of the late genes were replaced. In summary, a novel abi system that conferred resistance against 936 and P335 phages was isolated, at least two proteins were required for the anti-phage phenotype and they blocked a late step of the phage lytic cycle.

Key Words: *Lactococcus lactis*, Bacteriophages, Abortive infection

565 Human Flavor Threshold for Acetaldehyde in Milk of Various Fat Content, Chocolate Milk, and Spring Water. M. Van Aardt*¹, S.E. Duncan¹, and D. Bourne¹, ¹Virginia Tech, Blacksburg.

The implications of milkfat on detection threshold of acetaldehyde were determined on whole -, lowfat -, and nonfat milks, chocolate flavored milk, and spring water. Acetaldehyde threshold in milk of various fat content is of great importance to the dairy industry since acetaldehyde develops in milk during storage and it is also a degradation product of polyethylene terephthalate, a relatively new packaging choice for milk. Sensory threshold testing of all mediums was duplicated using a panel of 25 untrained subjects. Although acetaldehyde is lipid soluble, there was no significant difference in acetaldehyde threshold in milk of various fat content. Thresholds ranged from 3,939 to 4,040 ppb. Fat content seems to play no role in the flavor threshold for acetaldehyde in milk. Chocolate flavored milk and spring water showed thresholds of 10,048 and 167 ppb respectively, which compares favorably with previous studies. This high threshold of acetaldehyde in chocolate flavored milk is most likely due to masking of acetaldehyde flavor by chocolate flavor. Solid phase microextraction (SPME) was verified as an effective method for recovery of acetaldehyde in all mediums. Acetaldehyde could be detected as low as 200 and 20 ppb in milk and water respectively when using a Carboxen-PDMS SPME fiber in static headspace at 45 degrees C for 15 min

Key Words: Acetaldehyde, Threshold, Fat Content

566 Citrate catabolism and succinate production by Cheddar cheese nonstarter lactobacilli. E. G. Dudley*¹ and J. L. Steele², ¹University of Wisconsin-Madison Department of Bacteriology, ²University of Wisconsin-Madison Department of Food Science.

Succinate is an organic acid known to affect the flavor of fermented foods and beverages. Nonstarter lactobacilli (such as *Lactobacillus casei*, *Lactobacillus plantarum*, and other related lactobacilli) are primarily responsible for the production of succinate in Cheddar cheese, however limited information exists concerning the pathways utilized. Three strains of *L. plantarum*, and one strain each of *L. casei*, *L. zeae*, and *L. rhamnosus* were grown in a lactose and citrate containing complex medium under anaerobic conditions at 37C. All six strains were able to catabolize citrate. After 24h of growth, all strains had completely utilized the lactose present and had acidified the media to a pH between 4.8 and 5.2. Cells were harvested, washed, and resuspended in phosphate buffered saline containing 10mM: (1) citrate; (2) L-lactate; (3) both citrate and L-lactate; (4) aspartic acid; or (5) isocitric acid. After 24h incubation at 37C, the three strains of *L. plantarum* produced between 0.3 and 1.9mM succinate from citrate and between 0.8 and 2.8mM succinate from the combination of citrate and L-lactate. *L. plantarum* strains did not produce detectable levels of succinate from aspartic acid or isocitric acid. Also, no succinate production was detected with the other three *Lactobacillus* species under any of the conditions tested. Therefore, it appears *L. plantarum* produces succinate from citrate, and this pathway is enhanced by the presence of L-lactate. Current studies are aimed at deducing the pathways of citrate catabolism for these four *Lactobacillus* species.

Key Words: Lactobacillus, Succinate, Citrate

567 Effect of the combination of milk pre-acidification and cream homogenization on the post-baking chewiness and whiteness of low fat (6%) Mozzarella cheese. P. R. Benitez*¹, D. M. Barbano¹, and P. S. Kindstedt², ¹Cornell University, Ithaca NY, ²University of Vermont, Burlington.

Previous experiments have separately demonstrated that homogenization of cream increased whiteness and that pre-acidification of milk decreased post-baking chewiness of low fat Mozzarella. It has not been determined however, if the combination of these two techniques is effective. Cheese was manufactured by the stirred curd no brine method using a 3 x 3 randomized block design. The three treatments were milk pre-acidification (citric acid) to pH 5.8 without homogenization and to pH 5.8 and 5.6 with homogenization. Mean moisture (55.7, 59.0, and 61.7%, respectively) and calcium (0.55, 0.51, and 0.33%, respectively) content of the cheeses was significantly different among treatments. The initial apparent viscosity and TPA hardness of the pH 5.6 cheeses were significantly lower, due to their lower calcium and higher moisture content. Cheese chewiness was measured using an empirical sieving test. The initial cheese chewiness (27% of solids on sieve #4) of the pH 5.6 cheeses was similar to values obtained for typical LMPS Mozzarella and significantly lower than both pH 5.8 treatments (90%). Homogenization significantly increased cheese whiteness. At 4°C, the pH 5.8 and 5.6 homogenized treatments had Hunter L-values of 78.0 and 79.0 respectively, while the non-homogenized treatment was 63.4. The cheeses reached L-values between 85 and 90 when heated to 71°C. After 60 days of storage the difference in whiteness after heating to 71°C and cooling was significant with the pH 5.6 homogenized cheese retaining its white color the best with a final L-value of 83.9 at 7°C, in contrast to the non-homogenized cheese L-value of 74.7. Similar results were observed with a pizza bake test. It was determined that homogenization of cream

and pre-acidification of milk do not interfere with each other to produce a white but less chewy low fat Mozzarella cheese.

Key Words: Low fat Mozzarella, Pre-acidification, Homogenization

568 Effect of dissolved carbon dioxide on the thermal destruction of *Pseudomonas fluorescens* R1-232 in milk. C Loss*¹ and JH Hotchkiss¹, ¹Cornell University, Ithaca, NY.

Carbon dioxide (CO₂) is a natural component of milk and is added to dairy products to extend shelf life. The effect, if any, of this CO₂ on thermal destruction of spoilage microorganisms is unknown. Our objective was to determine if low levels of dissolved CO₂ significantly affected the thermal destruction of a common milk spoilage organism. *Pseudomonas fluorescens* R1-232 (isolated from milk) was inoculated into sterile milk and the thermal death time curves determined using the capillary tube method at 50 C. CO₂ was added at levels of 660, 920, and 1580 ppm. The pH was reduced by 0.37, 0.52, and 0.67 units for 660, 920, and 1580 ppm, respectively. Controls contained less than 50 ppm CO₂. A linear regression model was used to compare the slopes of the thermal death curves for different CO₂ concentrations (p≤0.05). Slopes were significantly affected by added CO₂. For example, 920 ppm dissolved CO₂ increased the negative slope of the survivor curve by 45% compared to controls. At this CO₂ concentration, the time to reduce the survivors by 90% was decreased from 14.3 minutes to 7.8 minutes. Thermal death time was linearly related to CO₂ concentration over the range of concentrations tested. These data suggest that low levels of dissolved CO₂ affects the efficacy of thermal treatment of milk. This may have implications for the pasteurization of milk containing dissolved CO₂.

Key Words: carbon dioxide, thermal death, milk

GRADUATE STUDENT PAPER COMPETITION ADSA PRODUCTION DIVISION

569 Effect of incubation fluid pH on the dry and organic matter degradation of alfalfa stems treated with fibrolytic enzymes. D. Colombatto*¹, F. L. Mould¹, M. K. Bhat², and E. Owen¹, ¹University of Reading, UK, ²Institute of Food Research, Norwich, UK.

The degradability of the dry matter (DM) and organic matter (OM) of alfalfa stems was examined *in vitro* using the ANKOM system, to evaluate the effects of incubation medium pH and fibrolytic enzymes addition. Bags containing approximately 0.5 g DM of pre-dried and milled (2 mm screen) alfalfa hay stems were placed in fermentation vessels and incubated anaerobically for up to 96 h at 39C. Rumen fluid was taken from a dry, grass hay-fed cow, and the incubation medium pH was adjusted to 6.72 (L1); 6.48 (L2); 6.20 (L3) and 5.72 (L4) using 1 M citric acid. For each pH level, a commercial enzyme mixture (Liquicell 2500, Speciality Enzymes, USA) was applied directly into the vessels at two levels: 0 (Control) and 7.58 units xylanase activity/g forage DM (determined on birchwood xylan at 39C and pH 5.5). Bags were removed in quadruplicate at 6, 12, 18, 24, 48 and 96 post-incubation, washed, dried and ashed to determine dry and organic matter degradation (DMD and OMD, respectively). The experiment was replicated twice. Decreasing the medium pH reduced (P<0.05) DMD from 374 to 333 g/kg; and OMD (from 385 to 345 g/kg) after 24 hours. End point (96 h) DMD was also affected (P<0.05), but the differences were small and likely to be of no biological importance (from 591 to 604 g/kg). In contrast, end point OMD did not change (P>0.05) due to pH effect. Enzyme addition increased (P<0.05) DMD and OMD after 24 h in L1 and L2 compared to their respective controls (374 vs. 419, and 369 vs. 416 g/kg; and 381 vs. 434, and 385 vs. 441 g/kg, respectively), but no differences (P>0.05) were found in L3 and L4. Also, enzyme addition did not affect (P>0.05) end point DMD and OMD, regardless of the pH level. It is concluded that Liquicell 2500, applied at the time of feeding, has potential to improve the DMD and OMD of alfalfa stems *in vitro*, but the medium pH appears to be an important factor in these responses.

Key Words: Fibrolytic enzymes, *in vitro*, pH

570 Milk response to concentrate supplementation of high producing dairy cows grazing at two pasture allowances. F. Bargo*, L.D. Muller, J.E. Delahoy, and T.W. Cassidy, The Pennsylvania State University, University Park.

Twenty Holstein cows (101 DIM, 631 kg BW, 4 ruminally cannulated) were assigned to five 4 x 4 Latin squares with 21-d periods. Cows within squares were assigned to four treatments: (LU) low pasture allowance-unsupplemented; (LS) low pasture allowance-supplemented; (HU) high pasture allowance-unsupplemented; (HS) high pasture allowance-supplemented. Cows grazed in two groups a grass pasture at allowances of 25 and 40 kg DM/cow/d. Supplemented cows received a corn-based concentrate (1 kg/4 kg of milk) and unsupplemented cows a mineral mix (1 kg/d) in two equal feedings after milking. Pasture and concentrate had 18.5, 12.4%CP; 53.6, 16.2%NDF; 69.3, 88.1% *in vitro* DM digestibility, respectively. Pasture DMI was measured in the 4 periods using Cr₂O₃ as fecal marker. Interaction between pasture allowance and concentrate supplementation was found for milk yield and total DMI. Milk response to supplementation was higher (1.36 vs. 0.96 kg milk/kg concentrate) and substitution rate was lower (0.26 vs. 0.55 kg pasture/kg concentrate) for cows grazing at low pasture allowance. Concentrate supplementation decreased fat but increased protein percent in milk. Milk urea nitrogen and rumen NH₃-N concentration decreased with supplementation. Interaction was found for rumen pH and total VFA concentration. Supplemented cows grazing at low pasture allowance (LS) produced the same amount of milk as HS with 37.5% less pasture offered.

	LU	LS	HU	HS	SEM	Effect
Milk, kg/d	19.1	29.7	22.2	29.9	0.8	PxC ¹
Fat, %	3.82	3.29	3.79	3.32	0.07	C ²
Protein, %	2.98	3.08	2.93	3.11	0.04	C ²
MUN, mg/dl	13.9	11.6	14.2	11.1	0.4	C ²
Total DMI, kg/d	18.3	24.1	21.3	24.8	0.4	PxC ⁴
Conc DMI, kg/d	0.7	8.6	0.7	8.7	0.1	C ²
Pasture DMI, kg/d	17.5	15.5	20.6	16.1	0.4	PxC ⁴
NH ₃ -N, mg/dl	15.2	9.1	15.3	8.7	0.5	C ²
pH	6.57	6.25	6.40	6.29	0.04	PxC ⁴
VFA, mm/L	116.3	130.0	129.8	130.6	2.3	PxC ⁴

^{1,4} pasture allowance x concentrate supplementation interaction (PxC), P<0.10 and P<0.05 ²concentrate supplementation effect (C), ³pasture allowance effect (P), P<0.05

571 Milk Production and Composition from Cows Fed Fish Oil, Extruded Soybeans, or Their Combination. L. A. Whitlock*, D. J. Schingoethe, A. R. Hippen, R. J. Baer, N. Ramaswamy, and K. M. Kasperson, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Milk production and composition were measured for eight multiparous Holstein and four multiparous Brown Swiss cows which were randomly assigned in a replicated 4 x 4 Latin square design with 4 wk periods. The four treatments consisted of a control diet (C) with a 50:50 ratio of forage to concentrate, diet C with 2% (on DM basis) added fat from menhaden fish oil (FO), diet C with 2% added fat from extruded soybeans (ES), and diet C with 1% added fat from menhaden fish oil and 1% added fat from extruded soybeans (FOES). All diets consisted of 25% corn silage, 25% alfalfa hay, and 50% of the respective concentrate mix. Milk production from cows fed the C, FO, ES, and FOES diets was 31.8, 29.1, 34.4, and 31.2 kg/d, respectively. Milk fat (3.51, 2.85, 3.26, and 3.11%) was lower ($P < 0.05$) when fed FO, while protein (3.40, 3.47, 3.32, and 3.30%) was similar ($P > 0.05$) for all diets. Milk from cows fed the FO and FOES treatments had a four-fold increase ($P < 0.01$) in the concentration of cis-9 trans-11 isomer of conjugated linoleic acid (CLA) when compared to the C treatment, and a two-fold increase ($P < 0.01$) when compared to the ES treatment; transvaccenic acid (TVA) was similarly increased. These results indicate that, when fed with a fat source high in linoleic acid (i.e. ES), fish oil served as a rumen modifier to cause a greater than expected increase in CLA and TVA content of milk fat.

Key Words: Conjugated Linoleic Acid, Milk

572 Ascorbic acid and a Beta-glucan product from *Saccharomyces cerevisiae* influence on dairy calf well-being. C. A. McKee*¹, S. D. Eicher¹, and T. R. Johnson², ¹USDA-ARS, West Lafayette, IN, ²Purdue University, West Lafayette, IN.

Dairy calves are exposed to many stressors within the first few days of life affecting health, growth, and well-being. The objectives of this study were to measure the effects of a -glucan product and Vitamin C as supplements in milk replacer on behavior, health, growth and immune function and to determine the efficacy of these supplements to reduce the use of antibiotics in animal production. Health and growth parameters are reported here. Forty-eight Holsteins dairy calves were blocked by date of birth and placed on 1 of 4 supplements added to an all milk, milk replacer; control (C), -glucan (Bg), Vit C (AA), and -glucan plus Vit C (Both). Calves were fed 10% of their BW per day in two equal feedings (12.5% dry milk replacer). Supplemental Vit C (Stay-C; Roche Vitamins, INC.) was given at 250mg and -glucan product (Nutri-ferm, Energy Plus, Natural Chem Industries, LTD.) was added at 2.5% of dry milk replacer. Weekly BW, body temperature, and blood samples were taken for six weeks, starting three days after birth. Fecal scores, nasal and ocular discharge were recorded daily. Weekly hematology measures were hematocrit, fibrinogen, percent granulocytes and lymphocyte counts. Means reported are C, Bg, AA, and Both \pm SE, respectively. Hematocrit showed a main effect of Bg and an interaction of Bg and AA ($P < .01$; $29.64 \pm .22$, $29.68 \pm .21$, $30.48 \pm .22$, $28.47 \pm .24$). Interactions for AA and Bg were significant for BW change ($P < .01$), percent hematocrit ($P < .01$), fecal scores ($P < .01$), and fibrinogen ($P < .01$). Mean BW change was $1.81 \pm .12$, $1.96 \pm .12$, $1.48 \pm .12$, $2.32 \pm .12$ kg/wk, fecal scores were $1.38 \pm .03$, $1.55 \pm .03$, $1.48 \pm .03$, $1.38 \pm .03$, and fibrinogen was 411.09 ± 12.92 , 456.92 ± 12.76 , 442.34 ± 12.92 , 416.47 ± 13.63 mg/dl. AA, Bg, and Both tended to increase percent lymphocytes ($P < .10$). There were no significant effects on percent granulocytes and ocular discharge. This study suggests that supplemental ascorbic acid and -glucan synergistically improve weight gain, health status, and overall well-being of dairy calves.

Key Words: Ascorbic acid, Beta-glucan, Calves

573 Alteration of apoptosis-related gene expression and 92 kDa-gelatinase activity in *Escherichia coli* infected bovine mammary glands. E. Long*¹, A.V. Capuco², D.L. Wood², T. Sonstegard², G. Tomita², M.J. Paape², and X. Zhao¹, ¹Dept. of Animal Science, McGill University, ²USDA-ARS.

Induction of programmed cell death during experimentally induced mastitis was assessed. Expression of the Bcl-2 family of proteins, that are important regulators of apoptosis, was compared between uninfected and mastitic glands. Five hundred CFU of *Escherichia coli* (P4: 032) were infused into the left quarters of six healthy lactating Holstein cows and left rear quarters were biopsied 24 or 72 h post-infusion. Uninfected right quarters, biopsied before *E. coli* infusion, served as controls. Somatic cell counts (SCC) increased in 4 of 6 infused rear quarters and peaked 24 h after bacterial infusion (10.7×10^6 cells/ml). Body temperature also increased, peaking 12 h after infusion (40.1C). Bacteriological analysis of milk samples verified coliform infection in these 4 quarters. Western blot analyses were conducted using the mammary biopsies obtained at 0, 24 and 72 h post-infusion. Compared with uninfected controls, expression of the pro-apoptotic protein, Bax, increased in mastitic tissues 130 and 100% at 24 and 72 h, respectively. Conversely, expression of the anti-apoptotic protein, Bcl-2, decreased 75% at 24 h but did not differ significantly from controls 72 h post-infusion. Expression of Bcl-x was not affected by *E. coli* mastitis. Apart from altered expression of Bcl-2 family genes, activity of 92-kDa gelatinase increased 10- or 7-fold at 24 or 72 h after bacterial infusion. These results suggest that *E. coli* mastitis increase the incidence of programmed cell death in bovine mammary tissue. Degradation of the extracellular matrix by gelatinase may be a part of the apoptotic response to *E. coli* infection.

Key Words: *E. coli* induced mastitis, Programmed cell death, Gelatinase

574 Pregnancy rates to a timed insemination in lactating dairy cows pre-synchronized and treated with bovine somatotropin: cyclic versus anestrus cows. F. Moreira*, C. Orlandi, C. Risco, F. Lopes, R. Mattos, and W. W. Thatcher, University of Florida, Gainesville.

Bovine somatotropin (bST) increased pregnancy rates (PR) in cows that underwent a pre-synchronization (presynch) treatment prior to initiation of a timed insemination (TI) protocol. Objective was to use plasma progesterone (P₄) concentrations to examine presynch and bST effects on PR in anestrus and cyclic cows. The TI protocol was initiated at random stages of the cycle (control) or cows were pre-synchronized with two PGF_{2 α} (25 mg; i.m.) at 37 and 51 days in milk (DIM). The TI protocol was initiated at 63 DIM with GnRH (100 μ g; i.m.), PGF_{2 α} (40 mg; i.m.) 7 d later, GnRH 48 h after PGF_{2 α} , and cows were TI 16 h later. Injections of bST (500 mg; s.c.) started at first GnRH (bST63), or at TI (bST73), or at 147 DIM (control). Groups were: control/bST63 (G1; n = 82), control/bST73 (G2; n = 83), control/control (G3; n = 90), presynch/bST63 (G4; n = 82), presynch/bST73 (G5; n = 80), and presynch/control (G6; n = 82). Blood samples (BS) at 51 and 63 DIM identified anestrus (two consecutive P₄ \leq 1.0 ng/ml; n = 117) and cyclic cows (at least one P₄ > 1.0 ng/ml; n = 382). BS at 63 and 70 DIM identified occurrence of premature luteal regression (pre-reg; P₄ > 1.0 ng/ml and \leq 1.0 ng/ml, respectively). Presynch and bST increased PR (at 74 d after TI) in cyclic cows (Table) but did not affect PR of anestrus cows (overall PR = 20.7 ± 4.7 %). In cyclic cows, PR was less for pre-reg cows than for cows not having pre-reg (19.4 ± 8.8 % < 44.5 ± 3.4 %; $P < 0.01$). Incidence of pre-reg was less in presynch than in control cows (Table). Presynch and bST increased PR in cyclic but not in anestrus cows. Presynch increased PR by reducing the incidence of pre-reg.

Response	G1	G2	G3	G4	G5	G6	SE
PR %	34.2 ^{a1}	33.7 ^{a1}	25.3 ^{a2}	58.2 ^{b1}	56.1 ^{b1}	42.6 ^{b2}	2.8
Pre-reg %	12.0 ^a	12.3 ^a	22.2 ^a	5.0 ^b	4.8 ^b	7.7 ^b	1.5

^{a, b} Different superscripts within row indicate presynch effect ($P < 0.01$).

^{1, 2} Different superscripts within row indicate bST effect within control or presynch groups ($P < 0.04$).

Key Words: Bovine somatotropin, Pre-synchronization, Timed insemination

GROWTH AND DEVELOPMENT

575 Enhancing neonatal intestinal growth, development and repair following injury. J. Odle* and R.J. Harrell, *North Carolina State University, Raleigh.*

Early postnatal morbidity and mortality of mammalian neonates represent significant challenges to the agricultural and medical sciences. While many stressors come to bear on the neonate soon after birth, it is convincingly clear that gastrointestinal maladies are among the most prominent. This is not surprising given the relatively quiescent state of the intestine in utero and the rapid ontogeny required following birth. Furthermore, the intestinal mucosa, initially sterile, must be protected from viral and bacterial pathogens that are ubiquitous in the postnatal environment. Because the intestine is a "supply organ", the overall systemic health and vitality of the neonate hinges on its development and function. Therefore, understanding the role of various nutritional, hormonal and pharmacologic agents in ushering the growth, development and function of the intestine is seminal. Our studies have specifically examined rotaviral gastroenteritis, a leading cause of neonatal intestinal injury and diarrhea, with the ultimate goal of improving the rate and extent of recovery. Using rotaviral infection within a neonatal piglet model, we have shown that the level of enteral nutrition delivered post-infection can starkly affect the clinical, biochemical and immunological response during recovery. While a brief period of "gut rest" may be beneficial, if prolonged, it can significantly delay recovery. We also have documented a modest mitogenic response of damaged intestine to supplemental epidermal growth factor, and have shown attenuation of rotaviral damage to the intestine of pigs fed milk replacer formulated with plasma proteins compared with soy-protein-based formulas. However, we have been unable to measure beneficial effects of enteral glutamine or alanyl-glutamine. Our collective findings suggest several positive (but modest) effects of various enteral-treatment regimens/agents on intestinal recovery. Further research is needed to understand better the complex interplay between nutrients, growth factors, immunological, and bacterial determinants which impact intestinal health and ultimately neonatal vitality.

Key Words: intestine, growth, rotavirus

576 Effects of dietary energy and protein on the immunological performance of milk replacer-fed Holstein bull calves. B. J. Nonnecke*¹, M. E. VanAmburgh², M. R. Foote², J. M. Smith², and T. H. Elsasser³, ¹*National Animal Disease Center, USDA, ARS, Ames, IA*, ²*Cornell University, Ithaca, NY*, ³*BARC-East, USDA, ARS, Beltsville, MD.*

Nutrient requirements of preruminant dairy calves are not well described. Current practices, often favoring a least cost approach, may compromise growth performance and health. The present study evaluated and compared immune function in neonatal calves on a higher nutritional plane with that of calves fed a diet meeting current industry standards. Colostrum-fed, Holstein bull calves (n=19) were assigned randomly at ~4 d of age to one of two treatment groups. Treatment (TRT) 1 calves were fed a 20% crude protein (CP): 20% fat milk replacer (MP) at a rate of 1.4% BW of dry matter (DM)/d for 8 wk. Calves assigned to TRT 2 were fed a 30% CP: 20% fat MR at a rate of 2.4% BW of DM/d. The functional capacity of mononuclear (MNL) populations from peripheral blood collected at 0, 4, 6, and 8 wk during the study period was estimated using a battery of in vitro tests. Nitric oxide (NO) and interferon- γ production by mitogen-stimulated MNL were influenced ($P \leq .05$) by nutritional plane, whereas mitogen-induced DNA-synthesis and secretion of tumor necrosis factor- α and polyclonal immunoglobulin were unaffected ($P \geq .05$). The total number of peripheral blood leukocytes was also unaffected by nutritional plane. These results suggest that increased dietary energy and protein can modulate specific aspects of the neonatal immune system. Additional research is necessary to determine if these changes reflect increased immunocompetency (i.e. infectious disease resistance). Leukocytes from all calves demonstrated age-related changes in their capacity to produce IgM, both cytokines, and NO and to synthesize DNA, possibly reflecting the maturation of the calf's immune system.

Key Words: Nutrition, Preruminant calf, Immune function

577 Regulation of leptin and leptin receptor (LR) expression with chronic inflammatory challenge in the growing pig. K.L. Houseknecht¹, C.P. Portocarrero¹, M.E. Johnston², R.D. Boyd², M.E. Spurlock³, M.T. Leininger*¹, C.A. Bidwell¹, M.A. Mellencamp², and M.E. White⁴, ¹*Purdue University, ²PIC USA, Inc., ³Purina Mills, Inc., ⁴University of Minnesota.*

Leptin is an adipocyte-derived protein that regulates appetite and energy homeostasis. Leptin acts via binding and activation of LR; long-form LR predominate in the hypothalamus and are credited with the regulation of appetite control. Short form LR are found in most tissues, and in vitro studies implicate them in the regulation of peripheral tissue metabolism. In rodents, leptin has been implicated in regulating anorexia associated with acute inflammation. As it is not known how the expression of leptin and its receptors are regulated with chronic inflammation in swine, our aim was to determine the effect of serial inflammatory challenges on leptin and LR gene expression in adipose tissue and circulating leptin concentrations. Gilts and barrows (initial body weight ~ 65 kg) were assigned to Control (saline; gilts n=14, barrows n=12) or lipopolysaccharide (LPS; gilts n=11, barrows n=13) treatments. Animals were injected IM every 7 d for a total of 5 injections. The initial LPS dose was 15 $\mu\text{g}/\text{kg}$ BW; dosage was increased 50% each 7d. Blood samples were collected at -24 and +6 hr relative to the 5th LPS injection and at slaughter. Animals were slaughtered ~60 hr following the final injection. LPS reduced feed intake in barrows and gilts acutely (24 hr post-injection; $P < 0.01$) and chronically (28 days; $P < 0.05$). Leptin mRNA abundance in adipose tissue and serum leptin were not affected by LPS in either sex ($P > 0.05$). However, chronic LPS treatment caused a dramatic reduction in LR expression in adipose tissue of gilts (70%, $P < 0.002$) and barrows (81%, $P < 0.01$) compared to controls. As leptin is thought to regulate its own expression in adipose tissue as well as to regulate insulin action in the adipocyte, down-regulation of LR with chronic inflammation may have important implications for adipose tissue metabolism and whole-body energy homeostasis.

Key Words: leptin, inflammation, swine

578 Effect of endotoxin (LPS) challenge on pituitary-thyroid axis and extrathyroidal thyroid hormone metabolism in cattle. S. Kahl*, T.H. Elsasser, and T.S. Rumsey, *USDA, Agricultural Research Service, Beltsville, MD.*

Thyroid status is compromised in a variety of acute and chronic infections and contributes to the impaired growth performance observed during disease states. To simulate and assess the impact of low level disease stress on the coordinated response of the thyroid regulatory/response axis, graded levels of LPS challenge (0, .2, 1.0, 3.0 $\mu\text{g}/\text{kg}$ BW, i.v. bolus, E. coli 055:B5) were administered to experimental animals. Two heifers and 14 steers (Angus x Hereford, 243 \pm 4 kg) were assigned to control or one of the three levels of LPS treatment (n = 4) and were limit-fed an all-concentrate diet (15% CP, 3.08 Mcal/kg DM) for 5 wk to gain 1.25 kg BW/d. Saline or LPS were injected through the jugular vein and blood samples were collected at 0, 3, 6, 12, 24, and 48 h relative to injection. Liver biopsy samples were obtained 8 h after LPS injection. LPS did not affect plasma concentrations of thyrotropin (TSH) within 12 h after the challenge. After 24 h, TSH was higher, compared to controls, only in animals injected with 3 μg LPS/kg ($P < .05$). All LPS doses decreased ($P < .01$) plasma thyroxine (T_4) and triiodothyronine (T_3) at 6, 12, and 24 h. Negative response of T_3 , measured as area under the time x concentration curve (AUC), increased linearly with the log of LPS dose ($r^2 = .998$, $P < .05$). Plasma reverse- T_3 (rT_3) increased after all LPS doses at 6 and 12 h ($P < .01$) and after 1 and 3 μg dose at 24 h; the response in plasma rT_3 (AUC) increased linearly with the log of LPS dose ($r^2 = .999$, $P < .05$). Hepatic type-I 5'-deiodinase (5'D) activity was not affected 8 h after LPS challenge (1.36 \pm .13 nmol $\text{I}^- \times \text{h}^{-1} \times \text{mg protein}^{-1}$). Results indicate that the reduction in plasma concentration of T_4 and T_3 in the early phase of acute response to LPS in cattle is related to reduced activity of the thyroid gland rather than to altered pituitary secretion of TSH. The data (rT_3 and 5'D) also suggest that LPS challenge may affect peripheral metabolism of thyroid hormones outside the liver and/or by other types of deiodinases.

Key Words: Thyrotropin, Thyroid hormone, Endotoxin

579 Effects of endotoxin (LPS) challenge on plasma adrenomedullin responses in cattle: correlation with maintenance of insulin-like growth factor-I (IGF-I) status. T.H. Elsasser^{*1}, S. Kahl¹, T.S. Rumsey¹, E.E. Connor¹, and J.L. Sartin², ¹USDA, Agricultural Research Service, Beltsville, MD, ²Auburn University, Auburn, AL.

Accompanying the acute phase response (APR) to infection, blood shunting and regional tissue hypoxia contribute to free radical accumulation and disruption of tissue function. Tissue expression and circulating plasma concentrations of adrenomedullin (AM), a potent vasodilating peptide, increase with hypoxia and after in vivo challenge with bacterial toxins like LPS. The objective of the present study was to correlate the relative magnitude of AM response to LPS challenge with the capacity for steers to maintain normal plasma concentrations of IGF-I. Twenty-two Angus Hereford steers (mean BW 318 kg) fed to gain 1.25 kg/d were challenged with a single bolus of LPS (*E. coli* 055B5, iv; 0.2 µg/kg BW). Blood samples for plasma were collected at 0, 1, 2, 3, 6, 8, 12, 24, and 48 h relative to LPS; liver and kidney biopsy samples were collected at 8 h into Bouin's fixative for immuno-histochemical determination of nitrated proteins (a measure of aberrant nitric oxide-superoxide anion reactions), AM, and inducible nitric oxide synthase. Plasma IGF-I and AM were measured by RIA; plasma NO₂ and NO₃ (NOx) were measured by the Griess reaction. Animals were grouped by AM response, group 1 (G1) having responses < 100 pg/mL over baseline (22 pg/mL) and group 2 (G2) having AM responses > 150 pg/mL over baseline (P < .002). Decreases in plasma IGF-I in G1 were 11 and 27% lower at 8 and 48 h, respectively, after LPS than those in G2 (P < .02). Increases in plasma NOx (area under the curve) were 63% greater in G1 than G2 (P < .05). Cells with nitrated proteins were more frequent in G1 steers than G2 steers. IGF-I concentrations at 8 and 48 h were positively (P < .05) and NOx responses negatively (P < .05) correlated with AM response. In conclusion, steers with greater AM responses experienced fewer effects of the APR as reflected in lesser decline in circulating IGF-I concentrations.

Key Words: Endotoxin, Adrenomedullin, Insulin-like Growth Factors

580 Biological markers of neonatal calf performance: relationships among serum IGF-1, zinc and copper to poor growth in Holstein calves. T. W. Graham^{*1}, J. E. Breher¹, A. M. Oberbauer², J. S. Cullor², T. B. Farver², and M. E. Kehrl³, ¹Veterinary Consulting Services, Davis, Ca, ²University of California, Davis, ³USDA, National Animal Disease Center, Ames, IA.

The principle objective of this study was to examine for relationships between serum IGF-I and growth during the first 90 days of life in Holstein calves. Potentially explanatory or confounding variables included in these models were serum IgG, total protein (TP) or packed cell volume (PCV) at birth, gender, twin status, bovine leukocyte adhesion deficiency (BLAD), serum Zn and Cu. Holstein calves (n = 421) were fed colostrum and brought to a calf facility where measurements of weight, length, and height were recorded at birth, 30, 60, and 90 days. Jugular blood was drawn from calves on day 1 to determine PCV, TP, IgG, Zn, Cu, IGF-I, and BLAD genotype (homozygous negative for the D128G CD18 allele compared to the heterozygous condition). Jugular blood was also drawn on days 2 through 10, 30, 60, and 90 days to determine serum Zn, Cu, and IGF-I (predictor variables). Serum IGF-1 approximately doubled from birth (15 ng/ml) to 90 days (30 ng/ml) in bulls and heifers, with bulls having approximately 20% more circulating IGF-1 than heifers by 90 days of age. Consistently, twins had less circulating IGF-1 than singletons. Serum Zn decreased and Cu increased from birth to 90 days (1.2 to 1.0 ppm Zn and 0.5 to 0.7 ppm Cu). Stepwise multiple regression and logistic regression were used to examine the relationships between predictor variables and weight, height, and length at 30, 60, and 90 days of life. Higher birth weight, single male calves, higher serum IGF-I and Zn, and lower serum Cu and Cu to Zn ratio were positively associated with weight, length, and height (P<0.05). Birth weight was the most important predictor of calf growth. BLAD status did not significantly affect growth in this study. These results suggest that low birth weight, lower serum IGF-I, and inflammation are significantly associated with poor growth (birth to day 90) in neonatal Holstein dairy calves.

Key Words: IGF-1, Zinc/Copper, Inflammation

581 Infection of weaned pigs with *Salmonella typhimurium* alters plasma insulin-like growth factor binding proteins. J. E. Minton¹, S. K. Durham^{*2}, R. Balaji¹, and S. S. Dritz¹, ¹Kansas State University, Manhattan, ²Diagnostic Systems Laboratories, Inc., Webster, TX.

We demonstrated previously that infection of weaned pigs with *S. typhimurium* resulted in a suppression of circulating insulin-like growth factor-I (IGF-I). Plasma IGF-I was decreased by 24 h, and was maximally suppressed by 48 h following infectious challenge. Normally, IGF-I circulates primarily as a part of a ternary complex bound to IGF binding protein-3 (IGFBP-3) and the acid labile subunit. Thus, the fall in plasma IGF-I we have observed in diseased pigs may be associated with alterations in circulating concentrations of IGFBPs. The objective of the current investigation was to evaluate concentrations of the IGFBPs, primarily IGFBP-3, in plasma of pigs infected orally with *S. typhimurium* (S). Pigs were penned individually with ad libitum access to feed and water. After an acclimation period, venous catheters were placed in all animals. Pigs were given sterile broth (C; n = 4) or 3 X 10⁹ cfu S (n = 6) in 5 ml broth. Plasma was collected at 24 and 48 h after disease challenge. Plasma was subjected to western ligand blotting (WLB) utilizing ¹²⁵I-IGF-I and IGF-II. Images were evaluated for total IGFBPs by densitometric analysis. In addition, plasma samples were analyzed for content of IGFBP-3 utilizing an immunoradiometric assay (IRMA) developed for human IGFBPs. Total IGFBPs were similar between C and S treatments at 24 h, but were reduced (P < .01) in infected pigs at 48 h. Concentrations of IGFBP-3, as estimated by the IRMA, were similar between S and C treatments at 24 h, but tended to be reduced (P < .08) at 48 h in S (217 + 45.8 vs 365.5 + 56.2 ng/mL). The data suggest that reduced circulating IGF-I provoked by enteric disease is accompanied by changes in peripheral IGFBPs, including IGFBP-3.

Key Words: Disease, Insulin-like growth factor binding proteins, Pigs

582 Effects of endophyte-infected fescue seed on calf performance and physiological indices. C. Golden^{*}, M. Nihsen, S. Wright, M. Poole, T. Denard, E. Piper, and C. Rosenkrans, Jr., *University of Arkansas, Fayetteville.*

Cattle consuming endophyte-infected tall fescue (EIF) have reduced productivity. That production loss is reportedly exacerbated by heat stress and bacterial challenge. Our objective was to investigate the interactions between EIF seed on calf feed consumption, weight gain and hematology. Dairy crossbred calves (n = 20; 91 SE 14 kg) were assigned to dietary treatments within a 2x2 factorial design. Treatments were inclusion of non-EIF or EIF seed at 10% of total feed ration. On day 14, five calves were randomly selected from each dietary treatment to undergo stress (intraperitoneal injection of lipopolysaccharide *Salmonella typhimurium* (.7 microgram/kg BW) immediately followed by four hours of transportation). Individual calf weights were taken weekly and feed consumption recorded. Blood samples were taken at 0, 8, and 22 hours postinjection. Inclusion of EIF seed decreased (P < .05) calf weight gain (17 vs. 10 SE 1 kg), average daily gain (.76 vs. .37 SE .1 kg/d), and overall feed intake (4.8 vs. 4.0 SE .2 kg/d). Blood characteristics were not affected (P > .5) by an interaction between main effects. However, stress increased (P < .07) blood concentrations of white blood cells 22 hours after injection (10,500 vs. 18,450 SE 2380 cells/microliter), hemoglobin (109 vs. 119 SE 2.4 mg/ml), hematocrit (30.3 vs. 32.4 SE .8 %), and prolactin (6.6 vs. 14.9 SE 1.6 ng/ml). These data indicate that EIF seed and stress decrease animal performance. However, we did not detect an interaction between bacterial and transportation stress and ingestion of endophyte-infected fescue seed.

Key Words: Fescue, Stress, Blood

583 Effects of ivermectin and immune challenge on steers consuming endophyte-infected fescue hay. M. Nihsen^{*}, T. Bedingfield, T. Denard, M. Poole, S. Wright, Z. Johnson, E. Piper, and C. Rosenkrans, Jr., *University of Arkansas, Fayetteville.*

Fescue toxicosis has been studied for many years with limited success in producing an effective and efficient treatment. Our objective was to determine effects of ivermectin, and an immune challenge on steer physiological responses and performance while consuming endophyte-infected tall fescue hay. Crossbred steers (n = 64; 308 SE 9 kg BW) were allotted to treatment by a complete randomized block design with a 2x2 factorial arrangement of treatments. Main effects were: ivermectin

slow-release bolus (yes or no) and a lipopolysaccharide (*Salmonella typhimurium* .7 microgram/kg BW) immune challenge (yes or no). Four steers were placed in each of 16 pens and fed a dietary supplement (.45 kg/d per steer; coccidiostat and mineral supplement in a corn carrier) and ad libitum endophyte-infected tall fescue hay. Steer weights, feed consumption, and hematology were collected weekly. Data were analyzed with pen as the experimental unit. Average daily gain and feed intake were decreased ($P < .1$) for steers receiving both an ivermectin bolus and immune challenge when compared with steers receiving no bolus and immune challenge, and no bolus no immune challenge. Treating steers with an ivermectin slow-release bolus increased ($P < .05$) red blood cell counts (9,369 vs. 8,702 SE 2223 cells/microliter), hematocrit (32.5 vs. 31.0 SE .8 %), and hemoglobin (121 vs. 115 SE 3 mg/ml). Prolactin (8.3 SE 1.5 ng/ml) and leptin (2.6 SE .13 ng/ml) were not ($P > .6$) altered by either treatment. Serum alkaline phosphatase and cholesterol were not ($P > .6$) altered by either treatment; however, lactate dehydrogenase and triglycerides were altered ($P < .05$) by ivermectin bolus and immune challenge. These data suggest that ivermectin bolus may improve performance of cattle grazing endophyte-infected fescue by altering blood cell function.

Key Words: Fescue, Ivermectin, Stress

584 The effect of composition of liquid milk replacer at a low energy level on the small intestinal permeability of piglets after weaning. M.A.M. Spreeuwenberg^{*1}, J.M.A.J. Verdonk², and M.W.A. Verstegen³, ¹Nutreco, ²ID-TNO, ³University of Wageningen, The Netherlands.

A total of 36 pigs (25.8 \bar{n} 2.0 days, 7.8 \bar{n} 1.0 kg) were used to determine the effect of composition of liquid milk replacer at a low energy level on the small intestinal permeability after weaning. Pigs were allocated to three treatments with 12 piglets per treatment. The difference in three milk replacers is the ratio of lactose and protein, a high protein content is accompanied with a low lactose content (and vice versa). In the high protein diet, the control diet and the high lactose diet, the protein content was respectively 448.6, 299.5 and 150.3 g/kg of liquid milk replacer. The lactose content was respectively 73.5, 235.0 and 400.5 g/kg. The percentage of fat was in all compositions the same: 300 g/kg. The piglets were fed restricted to simulate the low feed intake after weaning. The average energy intake at day 1 till 4 was respectively 137.3, 350.0, 416.0 and 414.0 kJ DE/kg^{0.75} (std: 76.3, 105.8, 78.3, 97.7). No creep feed was provided during the suckling period. The piglets were housed individually in transparent plastic cages, so they had visible contact. At 1, 2 or 4 days after weaning the pigs were sampled at 3.5 m distal of the Ligament of Treitz, under general anaesthesia. Permeability coefficient (10^{-6} cm/s) was measured by Ussing chambre. Transcellular transport was measured by Gly-Sar, paracellular transport was measured by Mannitol. At a low energy level, the milk replacer with a high ratio of lactose / protein had a tendency to have less paracellular transport than the control diet ($P < 0.10$). Compared to day 1, day 2 and 4 had significant increased paracellular transport ($P < 0.05$). The ratio between trans- and paracellular transport was significantly increased for the milk replacer with the high ratio lactose / protein compared to the control ($P < 0.05$). In conclusion, the ratio between lactose / protein can influence the transepithelial transport.

Key Words: Weaned pigs, Milk replacer, Permeability

585 In Utero Dietary Conjugated Linoleic Acid (CLA) Alters Body Composition and Growth Rate in Newborn Pigs. S.P. Poulos^{*1}, M.J. Azain¹, and G.J. Hausman^{1,2}, ¹University of Georgia, Athens, ²USDA-ARS, Athens, GA.

CLA alters body composition when fed to growing animals. This study investigated effects of CLA fed during gestation and lactation on the growth and development of piglets. Sows were fed a control diet containing corn and soybean meal with 0.83% soy oil (n=8) or a 0.5% CLA diet containing corn and soybean meal supplemented with 0.83% CLA-60, ConLinco (n=6) from day 40 of gestation through weaning (day 28). Within 24 hours of birth (day 0), one male and one female piglet per litter were sacrificed. Body and organ weights recorded and tissue samples were frozen. Weights of remaining pigs were recorded on day 0, 7, 14, 21 and 28. Blood was collected on day 0 and 28. Two barrows and two gilts per litter were weaned onto a corn and soybean meal based diet until market weight. Animals were weighed 69 days post-weaning,

and loin eye area and backfat thickness were determined 133 days post-weaning. Sow's milk samples were collected on day 21 of lactation and fatty acid composition was determined using gas chromatography. Leptin concentrations of pigs' serum (days 0, 28) and sow's milk (day 21) were determined via RIA (Linco). CLA did not alter sow's feed intake, body weight, backfat thickness, or litter size and weight at birth ($P > 0.05$). CLA resulted in significant decreases in newborn pig heart, kidney, and lung weights, but not backfat weight relative to their body weights (day 0). Body weight and gain were decreased on day 7, 14 ($P < 0.05$) however, this effect was not significant at weaning ($P > 0.05$). There was no difference in either weight or weight gain post-weaning. There were no differences in serum leptin on day 0 and day 28 or in sows' milk on day 21 ($P > 0.05$). CLA decreased total milk fat by 17% ($P < 0.01$) and caused significant changes in the amounts of specific fatty acids resulting in an increase in % saturated fatty acids and a decrease in % unsaturated fatty acids in milk from day 21 of lactation ($P < 0.05$). In Utero Dietary CLA alters body composition in newborn pigs by altering organ weight, not backfat. Changes in subsequent growth rates until day 14 may be due to changes in the sow's milk composition since growth rate and body weight did not differ post-weaning. This effect may be of significance when feeding CLA and in helping to determine CLA's mechanisms of action.

Key Words: Conjugated Linoleic Acid (CLA), Swine, Body Composition

586 Adipose tissue characteristics of weanling pigs fed conjugated linoleic acid. V. L. Adams^{*1}, C. D. Gilbert¹, H. J. Mersmann², and S. B. Smith¹, ¹Texas A&M University, ²Children's Nutrition Research Center, USDA/ARS.

The purpose of the study was to determine if feeding conjugated linoleic acid (CLA) to weanling pigs depressed lipogenesis and preadipocyte proliferation in s.c. adipose tissue. Eighteen weanling pigs (17 d of age; 4.9 kg BW) were allotted randomly to sorghum-based diets supplemented with 1.5% tallow, corn oil, or CLA. The diets provide equal amounts of total lipid (4.5%), crude protein (20%) and cholesterol (0.2%). The piglets were fed a basal diet for 7 d and their respective diets for 35 d before slaughter. Body weights were not different (25.6 kg; $P = 0.66$) at slaughter. Subcutaneous adipose tissue explants were incubated with 10 mM [¹⁴C]glucose + 0.1 mU/mL insulin. Glucose incorporation into total lipids was 72.4, 76.0, and 109.7 nmol/(100 mg per h) for s.c. adipose tissue from tallow, corn oil, and CLA-fed piglets, respectively, and was unaffected by diet ($P = 0.20$). Tritiated thymidine incorporation into DNA in preadipocytes was 8,254, 9,295, and 7,415 dpm/(100 mg per h) for s.c. adipose tissue from tallow, corn oil, and CLA-fed piglets, respectively, and also was unaffected ($P = 0.61$) by diet. The CLA diet increased the concentration of 16:0, 18:0, and decreased 16:1, 17:1, and 18:1 (the last to 21%; $P < 0.05$), suggesting depression of stearoyl coenzyme A desaturase activity in the CLA-fed pigs. The concentration of CLA isomers was raised only slightly in s.c. adipose tissue by the CLA diet (from undetectable to 3% of total fatty acids) even though the CLA oil contained 44.5% CLA isomers. The data indicate that practical levels of supplementary CLA have little effect on the growth of weanling pigs or s.c. adipose tissue growth and development. However, CLA caused a more saturated fatty acid composition.

Key Words: Pigs, Lipogenesis, Fatty acid

587 Effects of conjugated linoleic acid on milk composition and baby pig growth in lactating sows. R.J. Harrell^{*1}, O. Phillips¹, D.L. Jerome², R.D. Boyd³, D.A. Dwyer⁴, and D.E. Bauman⁴, ¹North Carolina State University, Raleigh, ²ConLinco Inc., Detroit Lakes, MN, ³Pig Improvement Company USA, Franklin, KY, ⁴Cornell University, Ithaca, NY.

The lactating sow limits the growth potential of the neonatal pig by limiting the supply of nutrients and/or not providing the optimum balance of nutrients to maximize growth. Therefore, alterations in sow milk composition could improve piglet weight gains. Fifty-five mixed parity lactating sows (Landrace x Chester White) were blocked by parity and randomly assigned to receive either a corn-soybean meal diet (control) or a diet with 1% CLA-60 (conjugated linoleic acid, ConLinCo Inc. Detroit Lakes, MN). Diets were formulated to meet the nutrient requirements of a high producing lactating sow (NRC, 1998) and sows were fed to appetite. Treatments were initiated at approximately 4 d postfarrowing and continued until weaning at 22 d of lactation. Sow weights and backfat measurements were taken initially and again at weaning. Pig

weights and sow milk samples were collected initially, 7 d post treatment, and again at weaning. The inclusion of CLA did not alter sow ADFI, ending litter weights (average 60.9±1.0 kg) or litter size (average 10.3±1.1 pigs/litter), sow weight or backfat losses ($P > .20$). Milk samples from sows fed the CLA had a lower percentage of total solids ($P < .05$), fat ($P < .01$), and tended to have lower gross energy content ($P < .10$), but were not different in protein or ash content ($P > .20$). Milk samples from sows fed CLA had greater C12:0, C14:0, C16:0 ($P < .01$), and tended to have greater C18:0 concentrations ($P < .10$). However, sows that received CLA had milk with lower concentrations of C18:1 ($P < .05$), C18:2 ($P < .01$), and tended to have lower concentrations of C14:1 ($P < .10$), but were not different in C16:1 ($P > .10$) or C18:3 ($P > .20$) concentrations. These results suggest that sow milk fat content can be reduced with the dietary addition of CLA, but this did not result in any differences in piglet growth rate.

Key Words: Swine, Lactation, Conjugated linoleic acid

588 An immunocastration vaccine (Improvac®) increases growth in individually and group-housed boars. I. McCauley¹, G.M. Cronin¹, J.L. Barnett¹, K.L. Butler¹, D.P. Hennessy², R.G. Campbell³, B. Luxford³, R.J. Smits³, A.J. Tillbrook⁴, and F.R. Dunshea^{*1}, ¹Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Vic 3030, Australia, ²CSL Limited, Parkville, Australia, ³Bunge Meat Industries, Corowa, Australia, ⁴Monash University, Clayton, Australia.

A total of 120 entire boars (EB), 120 immunocastrate boars (IB) and 60 barrows (BA) were used in a study to investigate the interactions between sex (S) and housing (H) (group (G) vs individual (I) pens). The study consisted of 4 pens of 15 each of EB, IB and BA and 4 blocks of 15 each of individually housed EB and IB. IB were treated with Improvac® (2 ml) at 14 and 18 wks. Pigs were fed *ad libitum* and measures made between 18 and 23 wks. Data were analysed by an appropriate ANOVA with block/pens of 15 pigs as the experimental unit. The main effect of H was deliberately confounded with block effects in the design and thus cannot be legitimately reported. Also, the sed's relate only to comparing S within H. There were no SxH interactions for any variable. ADG was highest in IB (908, 1079, 944, 1098, 1225 g/d for GEB, GIB, GBA, IEB and IIB, respectively, sed=35.3 g/d) and since there were no differences in initial weight, final weight was also highest in IB (102, 109, 104, 113, 118 kg, sed=2.3 kg). Feed intake was highest in IB and lowest in EB (2518, 3050, 2871, 2881 and 3463 g/d, sed=112.1 g/d). FCR was highest in BA and similar for IB and EB (2.80, 2.88, 3.05, 2.64 and 2.83 g/d, sed=.112 g/d). P2 back fat was highest in BA and lowest in EB with IB intermediate (13.5, 15.3, 17.4, 13.5 and 16.0 mm, sed=.63 mm). Within boars, testes weight was higher in EB than in IB (475 vs 206 g, sed=24.0 g). Within the G pigs, EB had the most bouts of agonistic behaviour (27.9, 9.5 and 9.5 bouts/pig/d for GEB, GIB and GBA, respectively, sed=4.66 bouts/pig/d) at 21 wks of age. Improvac® treatment, used to eliminate boar taint, also improves growth performance. In group pens at least, this is associated with decreased sexual and aggressive behaviours. Supported by the Pig Research and Development Corporation

Key Words: Immunocastration, Vaccine, Boar

589 Vaccination of entire boars with Improvac® eliminates boar taint and increases growth performance. F.R. Dunshea^{*1}, C. Colantoni², K. Howard², P. Jackson¹, K.A. Long¹, S. Lopatnick¹, E.A. Nugent¹, J.A. Simons¹, J. Walker², and D.P. Hennessy², ¹Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia, ²CSL Limited, Parkville, Australia.

Three hundred (200 entire boars, 100 barrows) pigs were used in a 2x3 factorial design to assess the efficacy of a gonadotrophin releasing hormone (GnRH) vaccine, Improvac®, in eliminating boar taint. The respective factors were sex (barrows (BA), boars treated with placebo (EB) or boars treated with Improvac (IB)) and slaughter age (23 (E) or 26 wks (L)). Vaccines (2 ml) were administered 8 and 4 wks before slaughter. All IB exhibited anti-GnRH titres. Testes (467 vs 219 g) and bulbourethral gland (142 vs 64 g) weights were reduced ($P < .001$) and serum testosterone were below 2 nM in the majority of IB (94% and 92% at 2 and 4 wks post secondary vaccination, respectively). Boar taint, as assessed by the concentration of androstenone (1.21, .16 and .11 µg/g for EEB, EIB and EBA and 1.05, .13 and .10 µg/g for LEB,

LIB and LBA, respectively) and skatole (.133, .068 and .048 µg/g and .095, .056 and .046 µg/g) in subcutaneous fat, was suppressed ($P < .001$) to low or non-detectable levels in 100% of IB with the concentrations of taint compounds not significantly different to BA. No IB had high concentrations of both androstenone (>1.0 µg/g) and skatole ($>.2$ µg/g). In contrast, 49.5% of EB had high androstenone and 10.8% had high skatole, resulting in 10% of the EB with high concentrations of both compounds. IB grew more rapidly (786 vs 868 g/d, $P=.051$ and 858 vs 1119 g/d, $<.001$, for E and L) than EB with a similar FCR (3.03 vs 3.05 and 3.30 vs 3.10 for E and L) over the 4 wks after the secondary vaccination. Compared to BA, IB were leaner ($P < .001$) and more feed efficient ($P < .05$). The vaccine was well tolerated by the pigs, and no observable site reactions could be detected at slaughter. Vaccination of boars with Improvac® allows the production of heavy entire boars with improved meat quality through the prevention and control of boar taint.

Key Words: Immunocastration, Boar taint, Growth

590 An immunocastration vaccine (Improvac®) and porcine somatotropin (Reporcin®) have synergistic effects upon growth performance in boars. I. McCauley^{*1}, M. Kolek¹, D. Suster¹, W.T. Oliver², R.J. Harrell², and F.R. Dunshea¹, ¹Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia, ²North Carolina State University, Raleigh.

Sixteen individually-penned entire male pigs were used in study to investigate the interactions between commercial immunocastration vaccine (Improvac®) and porcine somatotropin (pST, Reporcin®) regimes. The study was a 2x2 factorial design with the respective factors being immunocastration vaccine (unvaccinated or 2 ml of Improvac® at 14 and 18 weeks of age) and pST (0 or 5 mg/d from 18 weeks of age until slaughter). Pigs were individually-penned and fed *ad libitum* until slaughter at 22 weeks of age. Chemical indicators of boar taint, androstenone (AEN) and skatole (SKA) were measured in fat samples by HPLC. As shown in the table below, while neither Improvac® or Reporcin® alone had any effect upon daily gain, the combined treatment increased daily gain by 25%. Feed intake was decreased by pST treatment but simultaneous treatment with Improvac® ameliorated the reduction in feed intake. FCR was not affected by Improvac®, but was reduced by pST treatment. Improvac® dramatically decreased testes size and the level of both boar taint compounds in fat whereas pST had no effect upon testes weight or fat SKA but reduced fat AEN. For fat AEN, the effects of pST and Improvac® were additive. In conclusion, Improvac® and Reporcin® have synergistic effects upon growth rate in individually-penned boars.

Vaccine (V) pST(P) mg/d	UV		Impro- vac		sed	Significance		
	0	5	0	5		V	P	VxP
Gain, g/d	1345	1396	1288	1677	98	.15	.015	.044
Feed intake, g/d	3630	3057	3751	3512	136	.02	.004	.13
FCR, g/g	2.77	2.29	3.10	2.09	.18	.64	<.001	.079
Testes, g	592	449	206	311	144	.030	.86	.25
SKA, µg/g fat	.16	.30	.02	.03	.09	.02	.29	.34
AEN, µg/g fat	2.75	1.50	.10	.01	.26	<.001	.011	.020

Key Words: Immunocastration, Porcine somatotropin, Boar

591 Effect of Paylean™ (ractopamine hydrochloride) on swine growth performance and carcass leanness as determined by 20- and 13-trial pooled summaries, respectively. D. J. Jones^{*1}, D. H. Mowrey¹, D. B. Anderson¹, A. L. Schroeder¹, E. E. Thomas¹, L. E. Watkins¹, R. E. Karnak¹, D. M. Roth¹, and J. R. Wagner¹, ¹Elanco Animal Health, Greenfield, IN.

The effect of Paylean on swine growth performance was evaluated from 1983 to 1993 in 20 dose titration trials involving 1,922 pigs. Barrows and gilts were fed 16% crude protein diets containing 0, 5, 10, or 20 ppm Paylean from approximately 67 kg to approximately 105 kg body weight. All growth performance data were taken after a 0-d Paylean withdrawal. Results showed that Paylean increased rate of weight gain ($P < 0.01$) and improved feed to gain ratio ($P < 0.01$) at all doses evaluated. In 13 of the 20 dose trials, carcass data were taken after either

a 0-d, 4-d, or 5-d withdrawal period. Dressing percent was increased at 5 ppm ($P < 0.05$), and at 10 and 20 ppm ($P < 0.01$). Loin eye area was increased ($P < 0.01$) for all doses and fat-depth at the tenth rib was decreased ($P < 0.01$) for the 10 and 20 ppm doses. Color, firmness, and marbling of the longissimus dorsi were not affected ($P > 0.05$) by any Paylean dose. Percentage dissected lean from the pork carcass was increased at the 5 ppm dose ($P < 0.05$) and at the 10 and 20 ppm doses ($P < 0.01$). Percent lean cuts (trimmed, boneless), determined only for the 20 ppm dose, were increased ($P < 0.01$). In conclusion, Paylean fed at 5, 10, or 20 ppm improves swine growth performance and increases carcass leanness without affecting meat quality factors.

Variable	Paylean, ppm				SE
	0	5	10	20	
Average Daily Weight Gain ¹ , kg	0.834	0.893	0.902	0.916	0.050
Average Daily Feed Intake ¹ , kg	2.99	2.95	2.91	2.88	0.02
Feed to Gain Ratio ¹	3.62	3.33	3.25	3.16	0.02
Dressing Percent ²	73.3	73.7	74.1	74.4	0.1
Loin Eye Area at Tenth Rib ² , cm ²	32.77	35.54	36.64	37.41	0.32
Fat Depth at Tenth Rib ² , cm	2.74	2.69	2.51	2.41	0.05
Dissected Lean ³ , % Trimmed, Boneless	51.8	53.9	55.6	57.5	0.7
Lean Cuts ⁴ , %	45.4	-	-	48.0	0.8

¹ 20-trial summary; ² 13-trial summary;

³ 6-trial summary; ⁴ 3-trial summary

Key Words: Paylean, swine growth, carcass leanness

592 Recombinant bovine somatotropin enhances growth rates in two species of ornamental fish; Giant Danios (*Danio aequipinnatus*) and Zebra Fish (*Brachydanio rerio*). P. R. Simpson^{*1}, B. C. Peterson¹, N. J. Hughes¹, and G. T. Schelling¹, ¹Department of Animal and Veterinary Science, University of Idaho, Moscow.

Zebra Fish (*Brachydanio rerio*) and other tropical fish, such as Giant Danios (*Danio aequipinnatus*), are often used as a model for growth development, molecular genetics, and immunology. Their small size is often a limitation in these studies. To address this, a 14-week growth study was initiated to determine the effects of recombinant bovine somatotropin (rbST; 5.0% dilution of Posilac) on growth performance and size; where Giant Danios (mean weight 2.87 ± 0.20 g) were allotted to two treatment groups with five replicates. Treatments were sham-injected controls (C) and 120 mg/g BW rbST (T). Fish were reared in 10 gal aquariums with individual filter systems at 27°C, and were hand fed twice daily to satiation. A high fishmeal commercial trout diet (55% crude protein) was used to provide for maximum growth. The fish received one intraperitoneal injection every 21 days starting on d 0. Fish were weighed weekly for 98 days. Resulting weights for d 28, 63, and 98 were 3.14, 3.50, and 3.86 g for C and 4.90, 7.41, and 8.86 g for T. Recombinant bST treatment increased ($P < 0.0001$) growth rates 538% throughout d 98, where total gain for C was 1.11 g and T was 5.99 g. The final weight of group T (8.86 g) was 129% greater ($P < 0.0001$) than group C (3.86 g). A similar study was conducted with Zebra Fish (mean weight 0.435 ± 0.05 g), using the same treatment groups. The resulting weights for d 14, 28, 42, and 56 were 0.479, 0.508, 0.568, and 0.575 g for C and 0.573, 0.569, 0.630, and 0.610 g for T. The initial 2 week growth response to rbST was maintained throughout d 56, with the lack of continued response possibly due to higher maturity level of the fish at the time of the trial. Administration of rbST can greatly increase the growth rates of Giant Danios, and was shown to have a short-term effect on adult Zebra Fish.

Key Words: Somatotropin, Giant Danio, Zebra Fish

593 Effects of replacing fish meal protein with meat and bone meal protein as a major dietary ingredient on growth performance in rainbow trout (*Oncorhynchus mykiss*). G.T. Schelling^{*}, M.T. Casten, N.J. Hughes, R.A. Roeder, and R.W. Hardy, University of Idaho, Moscow.

Feeding experiments were conducted to examine the potential of replacing fish meal protein (FM) with a standard, good quality meat and bone meal protein (MBM) in 25% increments for growing rainbow trout. With the objective of making an overall evaluation of growth performance and carcass composition, semi-purified diets were used to provide FM protein:MBM protein of 100:0, 75:25, 50:50, 25:75, and 0:100 as the sole dietary protein in isonitrogenous and isocaloric diets. Two hundred and twenty five rainbow trout (mean weight 120 g) were allotted to five treatments with three replicates in a randomized block design. The tanks were five cubic feet; water flow = 20.51 L/min; temperature = 15°C. The fish were hand fed to satiation twice daily and were weighed on d 0, 21, 42, and 63. Daily gain, daily feed intake, and feed/gain ratios were determined for growth performance. A sub-population of fish were sacrificed on d 63 for body composition determination by whole carcass proximate analysis. In the 100:0 diet, fish gained 3.8 g/d and the relative percentage gains for the series of diets with increasing MBM protein were 100, 90, 83, 85, and 59% (59 lower, $P < .05$). The feed/gain ratios were .94, .98, 1.04, 1.09 and 1.46 (1.46 less efficient, $P < .05$), respectively. There were no marked differences ($P > .05$) in dry matter and protein content of the whole body carcass fed the dietary treatments. The 0:100 diet resulted in reduced growth ($P < .05$) and therefore, had somewhat more carcass fat ($P < .05$). This work indicates that FM protein in semi-purified diets for rainbow trout can be replaced with 25 and 50% MBM protein with only 5 and 10% loss in F/G, and even up to 75% with a 15% loss in F/G.

Key Words: Meat and bone meal protein, Fish protein nutrition, Rainbow trout

594 Growth response of white sturgeon to bovine somatotropin dosage levels and administration patterns. G.T. Schelling^{*}, M.T. Casten, R.A. Roeder, and R.W. Hardy, University of Idaho, Moscow.

The slow growth of white sturgeon (*Acipenser transmontanus*) results in low production and propagation, and we previously reported a considerable growth increase when they were administered 80 µg bST/g body weight of bovine somatotropin (bST). It is the objective of this work to determine growth responses with 0 (C), 40 (L), 80 (M), and 120 (H) µg bST/g body weight (Posilac) administered intraperitoneally at 3 wk and 15 wk intervals. The sturgeon (initial wt. 1100 g) were grown in raceways that held 16°C water, and were fed a commercial trout diet. At the end of the 272 d trial, the C,L,M, and H treated fish weighed 2752, 4735, 5599, and 5706 g. The table shows the 6 wk period gains for the treatments that were administered at the first eight 3 wk intervals (first four 6 wk periods) and then terminated. The table reveals a considerable growth response (262% average) for the L, M, and H treatments at 3 wk intervals. The last column in the table demonstrates that during the last 6 wks of the 15 wk injection, the L period response dropped to that of C. However, both the M and H treatments were still producing a significant ($P < .05$) growth response. This work demonstrates the tremendous growth response that occurs when white sturgeon are administered bST. The low bST level provided for maximal gain when administered at 3 wk intervals, but higher dosage levels were required to maintain high gains over the 15 wk administration interval.

Table of Period Gains (g/d/fish)						
Injections	1 2	3 4	5 6	7 8	- -	- -
Control, gain	203	295	258	423	345	117
Low bST, gain	545	646	833	896	602	127
Med bST, gain	547	789	924	1133	705	340
High bST, gain	552	719	866	821	1139	502
Six-Week Periods	1	2	3	4	5	6

Key Words: Fish Growth, Somatotropin, Sturgeon

595 Growth response of rainbow trout to bovine somatotropin dosage levels and administration patterns. G. T. Schelling*, N.J. Hughes, P.R. Simpson, and B.C. Peterson, *University of Idaho, Moscow, ID / USA.*

A five-week growth study with juvenile rainbow trout administered a sustained-release bovine somatotropin (bST as Posilac[®]) was conducted to determine the effect of administration level and frequency on growth performance. The study was designed to evaluate the efficacy and efficiency of the sustained deliver system for fish. The treatments were: (C) control, (10/W)10 μ g bST/g BW/weekly, (20/W) 20 μ g bST/g BW/weekly, and (120/3W) 120 μ g bST/g BW/3 wks. Each treatment consisted of 3 replicate tanks of 5 fish having an initial weight of 16 g. The fish were grown in 15° C water and were hand-fed daily to satiety. A commercial high-fishmeal trout diet was used that contained 57% protein and met the recognized nutrient requirements. The fish were handled weekly for weighing and treatment, and all non-injected fish received a weekly needle puncture. The 5-wk gains for the fish were: 17.4, 32.1, 30.3 and 29.3 g/fish for the C, 10/W, 20/W and 120/3W treatments. All of the bST treatments resulted in increased gains ($P < .01$) of similar magnitude ($P > .05$). The average bST gain response over the controls was 75.9%. The F:G for the 4 treatments were 4.57, 3.11, 2.98 and 3.20, respectively. The average F:G improvement ($P < .05$) was 32.3%. The feed intake for the 4 treatments was 3.0, 4.2, 3.6 and 3.9 g/fish/week respectively, and was increased ($P < .05$) by all bST treatments by 30.0%. Previous work in this laboratory demonstrated that 120 μ g/g BW at 3 wk injection intervals was needed for maximal gain. Since the 10 μ g bST/g BW/wk treatment resulted in the same growth performance as the 120 μ g bST/g BW/3-wk period, there is at least approximately a 4-fold increase for bST by using the 3-wk injection frequency. The current work indicates that while the delivery system is efficacious for at least 3 wks, the efficiency is decreased relative to weekly administrations.

Key Words: Fish growth, Somatotropin, Rainbow trout

596 Differential expression of insulin-like growth factor binding proteins (IGFBP) -3 and -5 mRNA by primary porcine satellite cells. M.E. White*¹, H.R. Hathaway¹, and W.R. Dayton¹, ¹*University of Minnesota, St. Paul, MN.*

Muscle satellite cells are myogenic cells, which are critically important for postnatal muscle growth. The insulin-like growth factors (IGFs) are believed to play an important role in satellite cell growth and development and the biological activity of the IGFs is regulated by a family of IGFBPs. Other growth factors, which affect satellite cell growth, may work in part through the IGF-IGFBP system. We have reported previously that IGFBP-3 and -5 are produced specifically by porcine satellite cells (PSC) but not by muscle derived fibroblasts isolated from these primary cultures. The objective of this study was to determine the basal expression levels of IGFBP-3 and -5 steady-state mRNA levels in PSC cultures. IGFBP-3 and -5 mRNA were measured using ribonuclease protection assays (RPAs) using porcine-specific IGFBP-3 and -5 probes. PSC were isolated from the hind limb muscle of 7 wk old cross-bred pigs, plated on reduced growth factor matrigel 1:100 v/v-coated plates. Proliferating cultures of PSC in control media or exposed to growth factors for 18 hr were harvested and total RNA was extracted. Both IGFBP-3 and -5 mRNA are expressed by primary PSC cultures. IGFBP-5 mRNA expression level is significantly higher in these cultures than IGFBP-3 mRNA. These data indicate that PSC produce IGFBP-3 and -5 mRNA and that steady-state IGFBP-5 mRNA levels are higher than those of IGFBP-3 in these cultures.

Key Words: Satellite Cells, Porcine, IGFBP

597 Satellite cell activation, IGF-I mRNA, myostatin mRNA and hepatocyte growth factor (HGF) mRNA levels in the semimembranosus muscles of anabolic steroid implanted and nonimplanted feedlot steers. W. R. Dayton*¹, B. J. Johnson², M. E. White¹, and M. R. Hathaway¹, ¹*University of Minnesota, St. Paul,* ²*South Dakota State University, Brookings.*

Ribonuclease protection assays were used to measure the steady-state level of IGF-I mRNA in the semimembranosus muscles and livers of steers implanted from 32 to 38 d with Revalor-S, a combined trenbolone acetate and estradiol implant. Steady-state IGF-I mRNA levels were

73% higher ($P < .01$, $n=7$) in the livers of implanted steers than in the livers of nonimplanted, control steers. Similarly, steady-state IGF-I mRNA levels were 47% higher ($P < .01$, $n=7$) in the semimembranosus muscles of implanted steers than in the same muscles from nonimplanted, control steers. Steady-state hepatocyte growth factor and myostatin mRNA levels were not different in the semimembranosus muscles of implanted and nonimplanted steers. Circulating IGF-I concentration was 40% higher ($P < .01$, $n=7$) in implanted steers than in nonimplanted, control steers. Additionally, the number of actively proliferating satellite cells that could be isolated from the semimembranosus muscle was 45% higher ($P < .01$, $n=7$) in implanted steers than for nonimplanted steers. Viewed together these data suggest that elevated muscle IGF-I levels stimulate increased satellite cell proliferation that may contribute to the increased muscle growth observed in Revalor-S- implanted steers.

Key Words: Anabolic steroid, satellite cells, IGF-I

598 Fatty acid attachment to human growth hormone-releasing factors (1-29) and (1-44)NH₂ increases the release of GH and IGF-1 in growing pigs. P. Dubreuil*¹, T. Aribat², and P. Brazeau³, ¹*College of Veterinary Medicine, University of Montreal, QC, Canada,* ²*Asana Laboratories, Longueuil, QC, Canada,* ³*Notre-Dame Hospital, University of Montreal, QC, Canada.*

This study evaluated the effect of a fatty acid (hexenoyl trans-3 (A)) attachment to the Tyr-1 of the human (h)GRF(1-29)NH₂ and (1-44)NH₂ on GH or IGF-1 release. Male growing pigs between 35 and 45 kg BW were used. Human GRF(1-29)NH₂ was compared to AGRF(1-29)NH₂ following sc injection at doses of 1.25, 5.0 and 20 μ g/kg on GH profile. GH AUCs obtained were 3336, 3647, 3814 and 3948, 5979, 6323 ng/min/mL (SEM:425) for h and AGRF(1-29)NH₂, respectively. Greater GH AUCs were observed ($P < 0.05$) at doses of 5 and 20 μ g/kg of AGRF compared to hGRF suggesting a higher potency of AGRF. In order to extend the concept to hGRF(1-44)NH₂, 5 groups of 8 pigs were injected sc BID for 5 consecutive days with 1) saline (3 mL), 2) hGRF(1-44)NH₂ (30 μ g/kg), 3-5 AGRF (1-44) NH₂ at doses of 7.5, 15 and 30 μ g/kg. After 5 days of treatment, IGF-1 concentrations were 204, 221, 358, 306 and 401 ng/mL (SEM:25) for groups 1-5, respectively. IGF-1 concentrations were significantly higher ($P < 0.05$) in groups 3 and 5 than in the saline group indicating also a higher potency of this molecule. These data show that adding an hexenoyl chain to the Tyr-1 of the hGRF molecules increases the GH-releasing potency of both molecules. The mechanism by which these effects are achieved are unknown and under study. Study supported by Theratechnologies, Montreal, Canada

Key Words: GRF, GH, Pig

599 Induction of growth hormone (GH) messenger RNA (mRNA) by corticosterone (CORT) in cultures of chicken embryonic pituitary cells. I. Bossis* and T. E. Porter, *University of Maryland, College Park.*

We have reported that glucocorticoids can induce premature differentiation of GH-secreting cells both *in vitro* and *in vivo* during chicken embryonic development. In the present study, the mechanism of glucocorticoid-induced GH gene expression was assessed using quantitative *in situ* hybridization analysis for GH mRNA directly in cell culture plates. Values presented below are in counts per minute (cpm) from ³²P labeled GH riboprobe recovered after posthybridization washes. Embryonic day twelve (e12) pituitary cells were cultured for 48 hours in the presence of vehicle (VEH), GH-releasing hormone (GHRH) at 100 nM, CORT at 1 nM and GHRH plus CORT in combination. Steady state levels of GH mRNA were significantly affected by treatment (60 \pm 6, 218 \pm 13, 1720 \pm 35 and 10499 \pm 371 cpm for VEH, GHRH, CORT and GHRH plus CORT, respectively; $P < .0001$). In a second experiment, e12 cells were cultured in plates and treated for 0, 8, 16, 24 and 48 h with CORT at 1 nM. Duration of treatment with CORT significantly affected levels of GH mRNA (73 \pm 6, 465 \pm 16, 1224 \pm 29, 2144 \pm 42 and 1785 \pm 35 cpm for 0, 8, 16, 24 and 48 h, respectively; $P < .0001$). In a third set of experiments, e12 cells were cultured for 12 h in the presence of VEH, CORT at 1 nM, CORT at 1 nM plus cycloheximide (CHX) at 5 μ M and CHX at 5 μ M. Treatment with CHX significantly blocked the induction of GH mRNA by CORT (173 \pm 18, 1500 \pm 60, 242 \pm 32 and 68 \pm 12 cpm for VEH, CORT, CORT plus CHX and CHX, respectively; $P < .0001$). Culture of e12 cells in the presence of CHX at 5 μ M for 12 h followed by new medium with CORT at 1nM for 12h resulted in a substantial increase in GH mRNA, indicating that the substantial

reduction in responsiveness to CORT in the presence of CHX observed was not due to non-specific toxic effects. We conclude that induction of GH mRNA by corticosterone in chicken fetal pituitary cells is mediated by a protein(s) synthesized in response to corticosterone.

Key Words: Somatotroph, Corticosterone, Pituitary

600 Identifying differentially expressed genes in C2C12 myogenic cells using Differential Display PCR. J.B. Edeal*, C.D. Gladney, M.F. Allan, D. Pomp, and S.J. Jones, *University of Nebraska, Lincoln.*

To gain insight into the molecular mechanisms of skeletal muscle development, we searched for genes regulated by the differentiation of C2C12 myogenic cells. The differentiation of skeletal muscle starts when mononucleated myoblasts (MB) withdraw from the cell division cycle, align, elongate, and fuse into multinucleated myotubes (MT). Using Differential Display PCR (dd-PCR) in C2C12 myogenic cells, we tested the hypothesis that the differentiation of MB to form MT is accompanied by significant changes in gene expression. C2C12 cells were grown to 80-90% confluency in DMEM +10% fetal bovine serum. Differentiation was induced by the addition of DMEM + 2% horse serum + 10 μ M cytosine arabinoside. Total RNA was extracted from 6 culture plates (3 containing MB, 3 containing MT). cDNA from these samples was used as template for dd-PCR, providing three replicates within treatment. Bands were excised based on the consistency of banding within replicates (cell state) versus differences across cell type. To date, 100 primer combinations (5 anchor (3) x 20 arbitrary (5)) have been used to identify over 100 putative differentially expressed bands. Preliminary sequencing results from four of these bands yielded homologies to Myosin Light Chain-2, AMP deaminase 3, and Glutathione Peroxidase 1. Northern hybridization will be used to confirm differences observed in gene expression from the dd-PCR results. In the past it has been impossible to examine a large array of changes during this critical step in muscle growth. Differential Display PCR has allowed us to observe many differences in gene expression between two treatments (differentiated (MT), undifferentiated (MB)) in C2C12 myogenic cells.

601 The effect of LXR α activators on adipocyte differentiation. T.D. Brandebourg*¹, V.A. Manning¹, A.E. Brodie¹, and C.Y. Hu², ¹Oregon State University, Corvallis, ²Oregon State University and Sultan Qaboos University.

The objective of this study was to investigate a potential role for LXR α , a ligand-activated orphan receptor expressed in adipose tissue, in regulating adipocyte differentiation. 3T3-L1 preadipocytes were used to examine the effect of treatment with known activators of LXR α [22(R)-hydroxycholesterol (22R), 20(S)-hydroxycholesterol (20S)] on adipocyte differentiation. Cells were seeded at a density of 3×10^4 cells/cm³ on six-well (35-mm) tissue culture plates in 2 mL of DMEM medium plus 10% fetal bovine serum and were maintained at 37°C in a 5% CO₂-humidified environment. Cells were grown to confluence (d 2). On d 0, differentiation was induced by treatment with insulin (10 μ g/mL), dexamethasone (1 mM), and IBMX (.5 mM). Cells were treated with either ligand or carrier (ETOH) from d 0 to d 7. In separate experiments, 22R or 20S was administered at concentrations of 2.5, 5, 10, or 20 μ M. Cholesterol (Chol), which does not appreciably activate LXR α , was administered at concentrations of 2.5, 10 or 20 μ M. Differentiation was evaluated by measuring sn-glycerol-3-phosphate dehydrogenase (GPDH; EC 1.1.1.8) activity on d 7. Independent experiments were performed on duplicate wells where n=3 for 22R and n=2 for both 20S and Chol. Protein content was determined by the Bradford method using bovine serum albumin as a standard. Compared to controls, 22R reduced GPDH activity (nmol/(min*mg protein) by 20% at 5 μ M (p<.05) and 40% at both 10 and 20 μ M (p<.01). Administration of 20S did not affect GPDH activity at 5 μ M (p<.08) and 10 μ M (p<.19) while significantly decreasing GPDH at 20 μ M (89%, p<.01). However, 20S appeared to affect cell viability at 20 μ M. Cholesterol administration did not have any effect on GPDH activity at any concentration examined. These data suggest the LXR α receptor may play an important role in inhibition of adipocyte differentiation.

Key Words: Adipose Tissue, Differentiation, LXR

602 Analysis of Adipocyte Gene Expression During Marbling in Angus X Hereford Steers. K. D. Childs*¹, M. Allan², D. Pomp², J. R. Malayer¹, R. D. Geisert¹, D. W. Goad¹, and J. B. Morgan¹, ¹Oklahoma State University, Stillwater, ²University of Nebraska, Lincoln.

Identifying genetic markers pertaining to specific traits for growth and carcass quality would be a substantial benefit to the beef industry. The present study was undertaken to test for differential gene expression in intramuscular adipocytes during fat deposition of feedlot steers. Angus X Hereford steers (n=50) that were fed a high-energy concentrate ration *ad libitum* for 20 (n=5), 86 (n=15), 121 (n=15) and 146 (n=15) d to obtain various developmental stages of marbling. Subcutaneous fat measurements at slaughter averaged 0.18", 0.29", 0.43" and 0.53" (P<.05), respectively. Carcass traits were statistically different (P<.05) between days on feed. Intramuscular adipose was excised from the *longissimus dorsi*, snap frozen in liquid nitrogen and stored at -80°C. Total cellular RNA was extracted with TRIzol and Dnased. RNA concentrations were normalized and pooled. Pooled samples of total RNA (2 μ g) representing each day on feed were then analyzed by differential-display polyamide chain reaction (DD-PCR), using 200 primer combinations comprised of 20 arbitrary (5') and 10 anchor (3') oligonucleotides. Band differences among treatment groups were scored and 70 bands of interest were harvested. Excised bands were reamplified by PCR, sequenced and submitted to GenBank for homology identification. From the 70 reamplified products, 35 did not sequence, 15 did not have homology in GenBank and 25 contained significant homology to known genes. Sequences encoding regions for the translational repressor of NAT1 (cytidine deaminase) and myopodin were evaluated in adipose from individual animals by Northern hybridization to confirm differential gene expression among treatment groups. Northern results suggest that both the repressor of NAT1 and myopodin are differentially expressed in younger/leaner animals versus older/fatter animals. Gene expression is altered during adipocyte differentiation in intramuscular adipose of fattening steers. (Research funded by Oklahoma Beef Industry Council)

Key Words: Adipose, Cattle, DD-PCR

603 Growth control of mouse mammary epithelial cells by keratin antibody-targeted liposomes containing oligonucleotides antisense to epidermal growth factor receptor. I.-S. Yuh*, S.-Y. Lee, and B.-J. Hong, *College of Animal Resources Sciences, Kangwon Natl. University, Chuncheon, Korea.*

Mouse mammary epithelial cells (NMuMG cells) were incubated by the addition of 17 β -estradiol (1nM, E)+progesterone (10nM, P) or E+P+EGF with or without various types of oligomers (21-mer) to EGF receptor activity domain (cDNA: +711-+731). Sense or antisense oligomers were encapsulated in protein A-bearing liposome. Uncoupled protein A and unencapsulated sense or antisense oligomers were separated from liposomes on Sepharose 4B columns (encapsulation efficiency of oligomers in liposome-protein A; 0.8%). Addition of E+P into various concentration of EGF showed the interaction in DNA synthesis between EGF and E+P (P<0.05). Antisense oligomers 1 μ M decreased DNA synthesis induced by E+P or E+P+EGF (53.4 or 65.6% inhibition to control, P<0.05). Sense oligomers (1 μ M) also inhibited DNA synthesis induced by E+P or E+P+EGF (P<0.05). However, random-sequenced oligomers (21-mer, 1 μ M) did not inhibit EGF-induced DNA synthesis. The inhibitory effect of sense oligomers should be due to the unexpected match to functional gene product in growth. Cells were bound with keratin monoclonal antibody (5 μ g/ml) and then incubated with dilution of protein A-bearing liposomes containing sense or antisense oligomers in the presence of E+P or E+P+EGF. Dose dependent inhibition of DNA synthesis was observed. In the presence of E+P+EGF, 10 or 100nM encapsulated antisense oligomers in liposome-protein A inhibited DNA synthesis by 71.2 or 78.9% to control, respectively (P<0.05). The encapsulated oligomers in liposome-protein A inhibited DNA synthesis at 100 fold lower concentration than the unencapsulated oligomers. Incubation with keratin monoclonal antibody increased uptake of oligomers by mammary epithelial cells for 6 hour incubation compared to those without keratin monoclonal antibody, however keratin monoclonal antibody effect was moderate in inhibition of DNA synthesis.

Key Words: Mammary, EGF receptor gene, Liposome

604 The effect of glucagon and insulin on β -oxidation of 1-¹⁴C-palmitate by piglet hepatocytes in primary culture. G. Matsey*, X. Lin, and J. Odle, *North Carolina State University, Raleigh.*

Two experiments were conducted to study the effects of glucagon and insulin on β -oxidation of 1-¹⁴C-palmitate by newborn piglet hepatocytes in primary culture. Hepatocytes were isolated from piglets chosen randomly after birth and prior to 12 h of age. Hepatocytes were plated into 25 cm³ culture flasks and allowed a 4 h pre-incubation phase at 37°C in basal culture media. Basal media was replaced with incubation media containing palmitate (0.5 mM) and hormones at 4, 22, 46, and 70 h from initial plating. The accumulation of ¹⁴C from 1-¹⁴C-palmitate in CO₂ and acid soluble products (ASP) was determined in duplicate using treatment media containing 1-¹⁴C-palmitate. Treatments for Exp. 1 (n=5) consisted of the application of two insulin/glucagon ratios (I 10⁻¹¹ M/G 10⁻⁶ M and I 10⁻⁸ M/G 10⁻¹⁰ M) in the presence or absence of palmitate (0.5 mM). Treatments for Exp. 2 (n=4) consisted of increasing glucagon concentrations (G 10^{-11,-9,-7,-5} M) against a fixed insulin concentration (I 10⁻¹¹ M) in the presence of palmitate (0.5 mM). DNA content for both experiments was unaffected by treatment but declined progressively (p < .001) with time by an average of 60% from 200 ± 59 to 80 ± 16 ug/flask. Results from Exp.1 and 2 revealed no effect (p>0.1) of treatment on the accumulation of ¹⁴C in CO₂ or ASP. However, in Exp. 2 there was a significant decline with time (p<.001) in the accumulation of ¹⁴C from 1-¹⁴C-palmitate in both CO₂ and ASP levels where accumulation dropped 50% (155 ± 10 to 78 ± 12 nmol/h/mg DNA) and 63% (282 ± 20 to 105 ± 23) respectively. These results indicate that chronic exposure of newborn piglet hepatocytes to widely divergent hormonal concentrations of insulin and glucagon resulted in no detectable alterations in β -oxidation of 1-¹⁴C-palmitate by newborn piglet hepatocytes in primary culture.

Key Words: fatty acid oxidation, hepatocyte, neonatal swine

605 Association of Endocrine Factors (Insulin-like Growth Factor-I and Binding Protein-3) with Litter Size in Yorkshire Breed. S.H. Yang¹, D.S. Seo¹, J.S. Yun*¹, W.J. Kang¹, K.C. Hong¹, S.S. Park², and Y. Ko¹, ¹*Department of Animal Science, ²Graduate School of Biotechnology, Korea University.*

The litter size has been one of important economic traits in pig reproduction. Insulin-like growth factor-I (IGF-I) has been shown to mediate actions of steroid hormone or synergize with other endocrine factors so that it consequently plays roles in reproductive processes, including ovulation, implantation, maintenance of pregnancy, and fetal development. But, the effect of serum IGF-I on porcine litter size has not been studied much. Therefore, this study was conducted to relate serum estradiol (E2), progesterone (P4), IGF-I concentration, and IGF binding protein (IGFBP)-3 expression with porcine litter size. Moreover, the possible association with estrogen receptor (ER) as a candidate gene for the litter size was investigate. Sera from estrous cycle to postnatal growth were collected from pigs in two groups showing high and low litter sizes. Serum E2, P4, and IGF-I concentration were measured by RIA and IGFBP-3 expression was detected by ligand blotting. DNA extracted from blood was utilized for PCR-RFLP to analyze ER genotypes of pigs in each group, which produced three polymorphic patterns. During estrous cycle, IGF-I and P4 concentration in both groups decreased from metestrus to estrus, but IGFBP-3 and E2 showed opposite expressions. Also, IGF-I and IGFBP-3 concentration decreased gradually as pregnancy proceeded. Unlike E2 and P4, IGF-I and IGFBP-3 decreased moderately as new born pigs grew. Significant differences in IGF-I amount between two groups were partially detected at metestrus (P<0.001), day 40 (P<0.05) of pregnancy, and day 30 (P<0.05) of postnatal growth. Furthermore, based on the ER genotype analyzed, low litter size group showed higher IGF-I concentration than high litter size group during the pregnancy and postnatal growth. Taken together, the results indicate that the serum IGF-I was correlated with steroid hormones system but not intimately with litter size in pigs. But, if the expression of IGF-I and IGFBP-3 were examined together with ER genotype, it is possible to utilize IGF-I as a probe for predicting the litter size in pigs. Thus, this study implies that porcine litter size might be affected by IGF-I through a mechanism acting locally at the ovary.

Key Words: Pig, IGF-I(Insulin-like Growth Factor-I), Litter Size

606 Quantification of bovine liver pyruvate carboxylase and phosphoenolpyruvate carboxykinase mRNA by Northern blot analysis. C. Agca* and S.S. Donkin, *Purdue University, West Lafayette, IN.*

Pyruvate carboxylase (PC; EC 6.4.1.1) and phosphoenolpyruvate carboxykinase (PEPCK; EC 4.1.1.32) are two rate limiting enzymes for gluconeogenesis. These enzymes are regulated, at least in part for bovine, through changes in mRNA abundance. Northern blot analysis provides data for relative differences between samples for a specific mRNA, but fails to provide quantitative information between two different mRNA species. In order to overcome this limitation, 1050 bases of bovine PC and 1150 bases of bovine cytosolic PEPCK were cloned into transcription vectors. Plasmids containing PEPCK and PC inserts were linearized, and sense cRNA strands were synthesized and quantified. Total RNA (20 μ g) from liver biopsy samples from 7 cows on -28 and +1 day relative to calving were separated by agarose gel electrophoresis. The electrophoresis was interrupted and 12, 25, 50, 100, 200, and 400 μ g of PEPCK cRNA and 1.5, 3, 6, 12, 25, 50, and 100 μ g of PC cRNA were added to the sample wells and the electrophoresis was continued. The RNA was transferred to Genescreen membrane, which was hybridized sequentially with ³²P labeled PEPCK and PC cDNAs. The abundance of mRNA (pg/ μ g total RNA) between samples taken on -28 and +1 days relative to calving is similar for PEPCK (17.3 ± 6.6 and 15.5 ± 6.7). However PC mRNA abundance is higher (P < 0.05) on +1 day (1.9 ± 1.1) compared to -28 day relative to calving (0.5 ± 0.2). The PEPCK to PC mRNA (pg/pg) ratio is diminished (P < 0.05) between -28 and +1 days relative to calving (35.2 ± 18.4 vs. 8.8 ± 3.8). This method provides quantitative information combined with the simplicity of Northern blot analysis to enable a direct comparison of changes in expression of PC and PEPCK mRNA. Results point to large differences between absolute quantities of PEPCK and PC mRNA. The relative quantities of these mRNA, assuming similar translational efficiencies, indicate that an increase in PC can contribute to increased gluconeogenesis from pyruvate at calving despite a lack of change in PEPCK.

Key Words: Pyruvate carboxylase, Phosphoenolpyruvate carboxykinase, Gene expression

607 Cloning of bovine hepatic cytosolic and mitochondrial phosphoenolpyruvate carboxykinase mRNA and expression in bovine liver. C. Agca*, R.B. Greenfield, and S.S. Donkin, *Purdue University, West Lafayette, IN.*

Phosphoenolpyruvate carboxykinase (PEPCK; EC 4.1.1.32) is compartmentalized in the cytosol and mitochondria and these forms are encoded by two different genes. Ruminant liver contains approximately equal activities of mitochondrial PEPCK (PEPCK-M) and cytosolic PEPCK (PEPCK-C). Our objective was to clone the two forms of bovine PEPCK cDNA and determine their expression in liver before and after calving. Regions of identity for human, rat, and mouse PEPCK-C and mouse and human PEPCK-M mRNA were used to design primers for reverse transcriptase-PCR. The 5' and 3' rapid amplification of cDNA ends protocol was used to clone the 5' and 3' ends of PEPCK-C and 3' end of PEPCK-M mRNA. The PCR products of PEPCK-C and PEPCK-M were ligated to pGEM 3Z plasmid and sequenced. Bovine PEPCK-C mRNA contains 2592 nucleotides, and encodes 622 amino acid. The cDNA coding sequence of bovine and human PEPCK-C show 84% identity. A partial clone of the 3' end of PEPCK-M contains 460 bases. The PEPCK-M clone is 76% identical to the corresponding human sequence. The coding sequence of bovine PEPCK-C is 54% identical to bovine PEPCK-M with negligible identities of 3' untranslated region. The 3' end clones were chosen as cDNA probes due to sequence differences. Total RNA from liver biopsy samples obtained from 10 cows at -28, -14, +1, +14, and +56 relative to calving were used for Northern blot analysis of PEPCK-C and PEPCK-M. Northern blot analysis shows that both PEPCK-C and PEPCK-M mRNA are approximately 2.5 kb. The correlation coefficient of PEPCK-C and PEPCK-M is 0.54. The mRNA PEPCK-C is increased (P<0.05) at 28 days after calving yet the abundance of PEPCK-M is unchanged during this period. The ratio of PEPCK-C to PEPCK-M is increased (P<0.05) during this interval. Because PEPCK-M provides 50% of the total PEPCK activity in ruminants, it may play an important role in gluconeogenesis yet PEPCK-M mRNA does not appear to be specifically regulated during the transition to calving.

Key Words: Gene expression, Compartmentalization, Phosphoenolpyruvate carboxykinase

608 The somatotrophic axis of young calves can be modulated by nutrition and bST. A.L. Bork*, J.M. Smith, M.R. Foote, and M.E. Van Amburgh, *Cornell University, Ithaca, NY.*

Our objective was to investigate the responsiveness of the somatotrophic axis in young calves. We hypothesized that young calves provided a higher plane of nutrition would express improved growth rates, higher insulin-like growth factor-I (IGF-I) levels, and a greater response to bST treatment. Nineteen neonatal Holstein bull calves were randomly assigned to one of two treatment groups at an average age of 4.2 d (week one) and fed milk replacer (MR) until nine weeks of age. Treatment (TRT) 1 calves were fed MR containing 20% crude protein (CP), 20% fat at a rate of 1.4% body weight (BW) dry matter (DM) per day. Calves assigned to TRT 2 were fed a 30% CP, 20% fat MR at a rate of 2.4% BW DM per day. Calves were weighed weekly on two consecutive days and DM intake was adjusted accordingly. At five weeks of age, on three consecutive days, all calves were given a daily injection of bST (120 μ g/kg BW). Blood samples were obtained every Tuesday and immediately prior to first bST injection and 14 and 24 hours after the third injection. Plasma samples were later analyzed for IGF-I by radioimmunoassay after glycyl-glycine extraction. Average growth rates for calves assigned to TRT 1 and TRT 2 were 0.44 and 1.10 kg/day ($P < 0.001$), respectively. From week two to week nine of life, calves assigned to TRT 2 had higher circulating IGF-I levels compared to TRT 1, (128.5ng/ml vs. 73.3 ng/ml for TRT 2 and 1, respectively ($P < 0.001$)), consistent with the higher energy and protein intake. Calves on both treatments responded similarly to the bST challenge (40% increase in circulating IGF-I levels). Surprisingly, however, calves assigned to TRT 2 exhibited a 460 g/d increase in growth rate for the seven day period following bST challenge with no change in intake. Calves assigned to TRT 1 did not exhibit a change in growth rate. We conclude that the somatotrophic axis is functioning in young calves, and that calves on a high plane of nutrition are not only able to respond to a bST challenge with higher IGF-I, but also exhibit a growth response at five weeks of age.

Key Words: Calves, Nutrition, IGF-I

609 Thyroid hormones regulate somatotroph abundance during chicken embryonic development. L. Liu* and T. E. Porter, *University of Maryland, College Park.*

We reported previously that corticosterone can induce somatotroph differentiation *in vitro* and *in vivo* and that triiodothyronine (T_3) can act synergistically with corticosterone to further augment the abundance of somatotrophs *in vitro*. The objective of the present study was to test our hypothesis that thyroid hormones regulate the abundance of somatotrophs during chick embryonic development. First, we tested if administration of T_3 to developing chick embryos could increase somatotroph proportions prematurely *in vivo*. Somatotroph differentiation normally occurs between embryonic day 12 (e12) and e16. The albumen of fertile eggs was injected on e11 with T_3 (12 pg, 120 pg, 1.2 ng). The embryos were then allowed to continue developing until e13, when pituitary cells were isolated and subjected to reverse hemolytic plaque assays and immunocytochemistry to detect GH-secreting and GH-containing cells, respectively. Injection of T_3 increased GH-secreting cells to $7.6 \pm 0.7\%$ (12 pg of T_3) and $8.4 \pm 0.6\%$ (120 pg of T_3) of all pituitary cells ($P < 0.05$), compared to $3.8 \pm 0.6\%$ for basal levels. The 1.2 ng dose of T_3 was ineffective. The percentage of GH-containing cells was increased from the control level of $4.6 \pm 0.9\%$ to $7.4 \pm 0.9\%$, $9.4 \pm 0.9\%$ and $12.6 \pm 0.9\%$ by 12 pg, 120 pg and 1.2ng of T_3 , respectively ($P < 0.05$). Next, we evaluated the effects of the thyroid hormone synthesis inhibitor methimazole on somatotroph differentiation during development. Injection of 5 μ g of methimazole on e9 decreased the abundance of GH-containing cells on e14 from $13.7 \pm 0.5\%$ for vehicle treated embryos to $7.8 \pm 0.5\%$ ($P < 0.05$). Taken together, these results indicate that treatment with exogenous thyroid hormones can modulate somatotroph differentiation and that endogenous thyroid hormone synthesis may contribute to normal somatotroph differentiation. Since we reported that T_3 alone was ineffective *in vitro*, we interpret these findings to indicate that effects of treatments *in vivo* were due to interactions with endogenous glucocorticoids.

Key Words: Somatotroph, Triiodothyronine, Methimazole

610 Effects of recombinant bovine somatotropin (rbST) and nutrition on growth and muscle fiber profiles in early-weaned beef steers. K. E. Moulton*¹, T. G. Althen¹, A. R. Williams¹, L. R. Jefcoat¹, A. B. Moore¹, M. B. Solomon², and J. S. Eastridge², ¹Mississippi State University, Mississippi State, ²Beltsville Agricultural Research Center, USDA, Beltsville, MD.

Our objective was to determine effects of rbST and nutrition on growth and fiber profiles in beef calves. At 100 d of age, 48 crossbred steers were trained on the Calan Feeding System. At 155 d of age, steers were assigned to treatments in a 2x2 factorial design testing the effects of protein fed at levels according to NRC (NP), vs high protein diet (125% of NRC, HP) and rbST (Posilac, 2.2 mg/kg/14 d s.c., ST) vs no rbST (C). Blood samples were taken every 14 d for IGF-1 analysis. Treatments continued until 255 d of age and semitendinous muscle biopsy samples were collected to determine myofiber morphology. Every 28 d steers were evaluated via ultrasound for backfat (BF) and REA. The C-NP, C-HP, and ST-NP steers consumed more feed than the ST-HP steers (850, 878, 847 vs 724 kg, $P < 0.05$). The ST steers had improved feed efficiency (FE) when compared to C (0.17 vs 0.15 G/F, $P < 0.05$). Treatment with ST reduced BF (.59 vs .51 cm, $P < 0.05$) and tended to increase REA (54 vs 51 cm², $P = 0.07$) at 255 d when compared to C steers. Steers fed the NP diet had more BF than steers fed the HP diet (.58 vs .52 cm, $P < 0.05$). IGF-1 concentrations, cross-sectional areas for fiber types, and percentage distribution of SO fibers were not different between treatments ($P > 0.10$). The ST treatment resulted in a decrease in percentage FOG (26 vs 31%, $P < 0.05$) and increase in percentage FG (58 vs 53%, $P = .05$) fibers when compared to C steers. Steers treated with ST gained more efficiently, have less BF and tend to have larger REA than controls. Although concentrations of IGF-1 in blood serum and fiber cross-sectional areas were unaffected by ST, percentage distribution of FG fibers increased and percentage distribution of FOG fibers decreased in ST steers. These data substantiate earlier findings by our lab and demonstrate that ST treatment alters myofiber morphology in beef calves.

Key Words: rbST, Beef Cattle, Muscle Fiber Types

611 Location and ontogeny of thyrotrophs during chicken embryonic development. M. Muchow*, I. Bossis, and T. E. Porter, *Department of Animal and Avian Sciences, University of Maryland, College Park.*

We demonstrated previously that messenger RNA levels for the beta subunit of thyroid stimulating hormone (TSH β) are maximal on embryonic day (e) 19 in chickens. However, little is known about the production of TSH β protein in this species. The present study used a heterologous antiserum to rat TSH β to determine the location and abundance of TSH β producing cells during embryonic development. Western blot analysis was performed to determine the specificity of the rat TSH β antiserum against the chicken protein. Rat TSH (10 ng), affinity purified chicken LH and FSH (1 μ g each), and homogenates of chicken pituitary, liver, heart, and spleen (5 μ g of protein each) were separated on a 16% SDS-PAGE gel and transferred to a nitrocellulose membrane, which was probed with the rat TSH β antiserum. Identical peptide bands (about 17 and 30 kDa) were detected in both the rat TSH and the chicken pituitary samples. No bands were seen in the LH, FSH, or other tissue extract samples, supporting the specificity of the antiserum for chicken TSH β . Thyrotrophs were localized in whole mount preparations of e19 pituitaries both by immunocytochemistry (ICC) using the rat TSH β antiserum and by *in situ* hybridization (ISH) using a digoxigenin-labeled antisense riboprobe to chicken TSH β . Both ICC and ISH localized thyrotrophs to the cephalic lobe of the anterior pituitary. Next, ICC was performed on dissociated pituitary cells to define the ontogeny of thyrotrophs during development. Pituitaries from e11-19 embryos and day 1 posthatch chickens were isolated, dispersed by trypsin digestion, and subjected to TSH β ICC. TSH β cells comprised $0.7 \pm 0.1\%$, $4.0 \pm 0.4\%$, $5.3 \pm 0.4\%$, $7.0 \pm 0.8\%$, $6.7 \pm 0.7\%$, and $3.9 \pm 0.4\%$ of all pituitary cells on e11, e13, e15, e17, e19, and d1, respectively. Thus, thyrotrophs were rare on e11, and their abundance was maximal on e17 ($P < 0.01$, $n = 4$ separate trials). We conclude that TSH β -producing cells are located in the cephalic lobe of the anterior pituitary and that the size of the thyrotroph population increases prior to hatching.

Key Words: Thyrotroph, Chicken Embryo, Development

612 Partial feed restriction induces pyruvate carboxylase mRNA but not phosphoenolpyruvate carboxylase mRNA in liver of lactating dairy cattle. J.C. Velez* and S.S. Donkin, *Purdue University, West Lafayette, IN.*

The ability of dairy cattle to adapt to changes in nutrient intake requires appropriate changes in expression of several key genes in liver. We determined effects of partial feed restriction on expression of pyruvate carboxylase (PC), phosphoenolpyruvate carboxylase (PEPCK), growth hormone receptor (GHR), and insulin-like growth factor-I (IGF-I) mRNA. Six mid-lactation Holstein cows were fed a total mixed diet for ad libitum intake during a 6-day period. Liver biopsy and blood samples were obtained at the end of the period and cows were then restricted to 50% of ad libitum intake for 5 days. Liver biopsy and blood samples were obtained at the end of the second 5-d period and cows were readjusted to ad libitum intake. Liver biopsy samples were also obtained after 12-d of realimentation. Plasma non-esterified fatty acids (μM) were unchanged (235 vs. 252; ad libitum vs. feed restriction) by feed restriction. Northern blot analysis of total RNA revealed a tendency ($P < .15$) for increased expression of PC mRNA during feed restriction. Expression of PEPCK, GHR and IGF-I remained unchanged during this period. Expression of PC and IGF-I were elevated ($P < .05$) by 68% and 356% respectively during realimentation compared with the ad libitum feeding period but there were no differences for PEPCK or GHR mRNA. The lack of coordinated changes in PC and PEPCK mRNA suggests expression of these enzymes that is mediated by separate signals in bovine liver. The data also demonstrates compensatory overexpression of PC and IGF-I mRNA as a consequence of feed restriction and realimentation.

Key Words: Feed restriction, Gene expression, Gluconeogenesis

613 Production responses to different porcine somatotropin injection regimes. F.R. Dunshea*¹, ¹*Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia.*

Thirty-two female crossbred pigs (initial weight 75 kg) were utilised in this experiment to investigate the effect of differing porcine somatotropin (pST) regimes on growth performance. Pigs were kept in individual pens and fed *ad libitum* a wheat-based diet formulated to contain 14.4 MJ DE/kg and 180 g ideal protein/kg. Treatments were daily injection with saline (Sal), daily injection with pST (5 mg) (D), bidaily injection of pST (10 mg) (2D) and injection of pST (12 mg) every Monday, Wednesday and Friday (MWF) for 3 weeks. On the days that pigs were not receiving pST they were injected with saline (0.5 ml). pST treatment had no significant effect upon ADG, despite being 100 g/d greater in the 2D and MWF pigs. All pST regimes caused a reduction in feed intake and FCR. Feed intake decreased after the first injection and for the D group remained low and constant. Feed intake for the 2D group was also reduced but not to as great an extent as in the D group. Feed intake in the MWF group showed a clear temporal response with feed intake being low during the week but increasing over the latter part of the weekend. Thus, feed intake on Sunday through Monday was 400 g greater ($P < .001$) than on Saturday through Sunday. Therefore, it appears that the effects of pST may be reduced when a 3d interval is used between injections. P2 back fat was significantly reduced with all pST injection regimes. Alternative pST injection regimes can improve growth performance in finisher pigs.

	Sal	D	2D	MWF	sed	P-value
ADG, g/d	769	773	874	871	79.1	.369
Feed intake, g/d	2894	2000	2378	2512	154	<.001
FCR, g/g	3.88	2.66	2.76	2.89	.20	<.001
P2 backfat, mm	19.8	14.8	16.3	15.9	1.2	.003
Change in P2, mm	6.5	.3	2.2	1.8	1.4	.001
Dressing, %	71.8	71.1	71.3	71.0	.7	.618

Key Words: Porcine somatotropin, Swine, Growth

614 Response to repeated bST challenges around weaning in Holstein heifer and bull calves. J.M. Smith*, M.E. Van Amburgh, A.L. Bork, and M.R. Foote, *Cornell University, Ithaca, NY.*

Our objectives in the current study were (1) to compare the responses to repeated ST challenges during the weaning period, and (2) to compare the response to ST challenge between heifer and bull calves. Calves received 4 L colostrum initially, then were fed a 30% CP: 20% fat milk

replacer (MR) twice daily (MR DM at 2% of BW per d) and free choice water. Calves were weighed weekly and feed amounts adjusted accordingly. Calves were first offered starter (26.5% CP, 1.07 Mcal NEg/kg, DM basis) after reaching 100 kg BW. When starter was introduced, MR DM was offered at 1% BW per d for one week, then at 0.5% BW per d for one week before being discontinued. Blood was collected from three heifer and three bull calves during three 24-hr periods following bST challenges. The challenge protocol consisted of injecting 120 $\mu\text{g}/\text{kg}$ BW bST once daily for three days. The first bST challenge was performed when calves weighed about 105 kg. Two wk later, which was 10d after starter was first offered and MR restricted, the second bST challenge was performed. The third bST challenge took place two wk after the second challenge and 10 d after calves had been totally weaned off milk replacer. Blood was collected prior to the first bST injection (-72 hr) and at 0, 4, 8, 12, 14, 16, 18, 20, 22, and 24 hr after the third injection. Plasma aliquots were stored at -20°C until analyzed for IGF-1 by RIA. Growth rates for the heifers and bulls during the period encompassing the challenges were not significantly different ($P = .18$), averaging 0.97 and 1.11 kg/d, respectively. Circulating IGF-1 at -72 hr was not different ($P = .61$) between heifer and bull calves. For all calves the response to challenge, calculated as the difference between the 14-hr post-challenge value and the -72-hr value, was not different ($P = .902$) among the three periods before, during, and after weaning, but was greater in heifers than bulls ($P = .038$). We conclude that weaning does not necessarily lead to uncoupling of the somatotrophic axis and that it is reasonable to apply data derived from milk replacer-fed bull calves to heifers.

Key Words: calves, somatotropin, insulin-like growth factor

615 Accuracy of volume measurements by magnetic resonance imaging. A.M. Scholz*¹, A.D. Mitchell², P.C. Wang³, and H Song³, ¹*University Munich, Experimental Station Oberschleissheim, Germany,* ²*USDA, ARS, Growth Biology Lab, Beltsville, MD,* ³*Howard University, Washington, DC.*

Volume measurements of body regions were accomplished within three different magnetic resonance imaging (MRI) experiments on totally 96 pigs from 10 to 60 kg (MRI.I: n=28, MRI.II: n=22) and from 30 to 90 kg (MRI.III: n=46). The purpose was to evaluate the accuracy of MRI for predicting the chemical carcass composition (MRI.II, MRI.III), and the dissected weights of separate muscles or fat tissues (MRI.I). The MRI was performed on a Picker Vista 1.5 Tesla whole body magnet generating successive axial images with a slice thickness of 1 cm. The images were processed by means of a digitizing tablet using the Sigma Plot PC3D program for MRI.I and MRI.II, and by means of the 'Analyze' software (Mayo Foundation) for MRI.III. The whole volumes of both longissimus dorsi muscles (MLD), the overlying fat (BF), and ham muscles were quantified in MRI.I and MRI.II. In experiment MRI.III, the volume of both MLD and of the overlying fat was measured in a defined 10 cm section and the volume of the ham with overlying fat in a defined 15 cm section. A stepwise regression analysis was performed, estimating carcass lipid % (CLipid%) and carcass lean % (CLean%, sum of carcass protein % and water %) from volumes of MRI.II and MRI.III. A higher accuracy in estimating body composition resulted from a body weight range of 30 - 90 kg compared to 10 - 60 kg due to a very low variation in the pigs < 20 kg. However, the correlations (r) between the dissected weights and MRI volumes of specific tissue groups are very high in the weight range of 10-60 kg, e.g., with $r=0.967$ for MLD and $r=0.973$ for BF in MRI.I.

	CLipid% R ²	$\sqrt{\text{MSE}}$	C.V.	d.f.	Variables in the Equation
MRI.II	0.765	1.802	10.764	2	BF Volume, Total Fat-Muscle Ratio
MRI.III	0.898	1.500	6.945	2	Fat Volume LD, Fat-Lean Ratio HAM
CLean%					Total Fat-Muscle Ratio, BF Volume
MRI.II	0.702	2.174	3.056	2	Fat Volume LD, Fat-Lean Ratio HAM
MRI.III	0.857	1.625	2.181	2	Fat-Lean Ratio HAM

Key Words: Body Composition, Magnetic Resonance Imaging

616 Changes in total body and regional bone mineral content and bone density in pigs from 4 to 137-kilograms body weight. A. D. Mitchell^{*1}, A. M. Scholz², and V. G. Pursell¹, ¹USDA, Agricultural Research Service, Beltsville, MD, ²Ludwig Maximilians University-Munich, Oberschleissheim, Germany.

Traditional methods of assessing bone mineral deposition in pigs involve slaughter followed by dissection, ashing, and/or chemical analysis. By the use of dual energy X-ray absorptiometry (DXA) it is now possible to perform many of these measurements on the live animal. The purpose of this study was to quantify the changes in total body and regional bone mineral content (BMC, g) and bone mineral density (BMD, g/cm²) in pigs between 4 and 137-kg body weight (BWT). A total of 992 DXA scans were performed on anesthetized pigs, using a Lunar DPXL densitometer. Linear and polynomial regression analysis was performed using SigmaPlot 5.0 procedures. Relative to BWT, the BMC for total body, front legs, back legs, and trunk were described by 2nd order polynomial regression with R² values of 0.965, 0.931, 0.952, and 0.820, respectively. Relative to total body BMC, the BMC of the front legs, back legs, and trunk was described by linear regression with growth coefficients (b = slope) of 0.274, 0.298, and 0.213 and R² values of 0.97, 0.98, and 0.91, respectively. Likewise, the increase in BMD relative to BWT was described by 2nd order polynomial regression with R² values of 0.943, 0.905, 0.929, and 0.888, for total body, front legs, back legs and trunk, respectively. Relative to total body BMD, the BMD of the various regions was described by linear regression with growth coefficients (b = slope) of 1.75, 1.01, 0.99, 0.97, 0.93, 0.75, and 0.37 for the head, front legs, back legs, spine, pelvis, trunk, and ribs. Thus, during the growth of pigs from 4 to 137 kg, the largest increase in bone mineral deposition was observed in the back legs while the largest increase in bone mineral density was observed in the head.

Key Words: Bone Mineral Content, Bone Mineral Density, Swine

617 Dual energy X-ray absorptiometry accurately predicts whole body and carcass composition in pigs. D. Suster^{*1}, B.J. Leury², J.D. Wark³, D.J. Kerton¹, E. Ostrowska¹, and F.R. Dunshea¹, ¹Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Victoria, Australia, ²Dept. of Animal Production, University of Melbourne, Victoria, Australia, ³Dept. of Medicine, Royal Melbourne Hospital, Victoria, Australia.

An Hologic QDR4500 Dual energy X-ray absorptiometer (DXA) was used to determine body composition in 150 pigs ranging from 10 to 130 kg live weight. Pigs were slaughtered commercially after the final scan, eviscerated and the empty carcass scanned before chemical analysis. Values predicted by DXA for fat, lean and bone mineral (BM) mass, for live animal and carcass were compared with chemically determined values for empty body and empty carcass, respectively. Fat depth at P2 was measured directly. A linear regression model $y=ax+b$, where y is chemical composition and x is the DXA predicted value was used. Scan repeatability in the live animal was also examined by scanning 15 pigs (35-45 kg live weight) in triplicate. Lean tissue predicted by DXA (live animal, $y=.83x+1.98$, $rsd=1.79$ kg, $r^2=.99$; carcass, $y=.95x-.85$, $rsd=1.51$ kg, $r^2=.99$) was highly correlated with chemical measurements. While DXA slightly underestimated lean content of the carcass, it overestimated lean content of the live animal. At least some degree of overestimation in vivo presumably arose from water in the gut lumen being included as lean tissue. DXA predictions of fat (live animal, $y=1.33x-1.43$, $rsd=1.69$ kg, $r^2=.96$; carcass, $y=1.21x-.91$, $rsd=1.24$ kg, $r^2=.97$) were highly correlated with proximate analyses, although the in-built algorithms underestimated fat. A positive correlation was also observed between P2 fat depth and chemical fat but the correlation was not as strong as the DXA prediction ($rsd=2.89$ %, $r^2=.78$). Bone mineral predicted by DXA (live animal, $y=1.19+.22$, $rsd=.19$ kg, $r^2=.93$; carcass $y=1.07x+.09$, $rsd=.15$ kg, $r^2=.92$) also correlated well with chemical ash. Coefficient of variation for repeated scans are low for lean (CV=.32%), fat (CV=2.03%) and BMC (CV=1.72%). These data demonstrate the potential of DXA to determine body composition in the live animal and carcass, and to improve on current routinely used methods. Supported by the Pig Research and Development Corporation

Key Words: DXA, Swine, Body Composition

618 Body composition changes of Angus females from breeding through second parturition determined by real-time ultrasound. G. H. Rouse^{*1}, D. E. Wilson¹, C. L. Hays¹, and A. Hassen¹, ¹Iowa State University, Ames.

The objective of this research was to measure changes in muscle, subcutaneous fat, midintramuscular fat as 255 Angus females developed from initial breeding through second parturition. Real-time ultrasound scans and weights (WT) were collected serially 5 times on the females: before breeding (BB), before first parturition (P-1), at weaning (W-1), before second parturition (P-2) and at weaning (W-2). Ultrasound scans collected included fat thickness at the 12th rib (FTK), ribeye area at the same location (REA) and percent intramuscular fat (PF). Least squares means of these live animal measures are shown below. Weight and fat thickness increase in linearly except for a loss in weight and condition between first parturition and weaning. Ribeye area increased at each of the 5 scans, while change in % intramuscular fat were small, one percent. Heifers were divided into 3 frame sizes based on adjusted yearling hip height, less than 5, 5-6, and above 6. Smaller heifers had less PF $P<.05$ than large heifers at initial breeding and after their second calf $P<.10$. While these same smaller heifers had less FTK initially and more FTK after their second calf than the large heifers, the differences were not significant. These results indicate changes in FTK are much greater than changes in PF, while REA continued to develop even during weight and condition losses following first calving.

	FTK,cm	PFAT,%	Wt.kg	REA.cm2
BB	0.21±.20 ^{a,b}	4.95±.91 ^{a,b}	411.18±26.64 ^{a,c}	43.19±6.65 ^a
P-1	0.41±.07 ^{a,b}	5.13±.34 ^{a,b}	457.49±9.23 ^b	51.75± 2.47 ^b
W-1	.36±.03 ^a	4.53±.11 ^{a,b}	419.67±11.05 ^a	59.34±.8 4 ^c
P-2	.61±.08 ^b	4.11±.35 ^a	500.34±21.70 ^{b,c}	63.91±2. 59 ^d
W-2	.74±.18 ^b	5.11±.81 ^b	572.63±45.27 ^d	77.12±5.91 ^e

Least squares means within a column with a different superscript are statistically significant ($P<.05$)

Key Words: Beef heifers, Composition, Parturition ultrasound

619 Assessment of alternative linear statistical models for studying growth in crossbred lambs. G.J.M. Rosa^{*1,2}, M. A. Neres^{1,3}, C. Costa¹, and D. Gianola², ¹FMVZ-UNESP, Botucatu, SP, Brazil, ²Animal Sci. Department, University of Wisconsin, Madison, ³FCA-UNIMAR, Marilia, SP, Brazil.

Data were body weights of 32 Suffolk backcross lambs in a 2 × 4 factorial experiment (2 sexes; 4 rations). Each lamb was weighed at 24, 35, 46 and 57 days of age, creating a longitudinal series. The data were analyzed by likelihood-based and Bayesian linear methods under normality assumption. A first model was a split-plot in time, assuming constant residual variance and intra-lamb correlation. An alternative model was multivariate, allowing for heterogeneous variance and correlations, but at the expense of a less parsimonious parameterization. Additional models fitted different structures to the residual covariance matrix. These included a model with first-order auto-regressive, AR(1), residuals, as well as Toeplitz and compound-symmetry covariance structures. On the basis of Akaike's and Schwarz' criteria for model assessment, a linear regression on time with different coefficients for each ration and an AR(1) residual error term was found to have the better fit. A Bayesian version of this model, using flat priors and Gibbs sampling, led to estimates that were similar to those based on likelihood.

Key Words: Longitudinal data, Multivariate models, Lamb growth

620 A random regression model for analysis of lamb growth. G.J.M Rosa^{*1,2}, M. A. Neres^{1,3}, C. Costa¹, and D. Gianola², ¹FMVZ-UNESP, Botucatu, SP, Brazil, ²Animal Sci. Department, UW-Madison, WI, ³FCA-UNIMAR, Marilia, SP, Brazil.

A 2 × 3 factorial experiment was conducted to evaluate effects of sex of lamb and of dietary levels of hay (0, 15 and 30% in diet) on growth of Suffolk backcrosses. Data were from 12 animals of each sex. Body weights were recorded at 61, 75, 85 and 99 days of life, or until they reached 30kg (culling weight), producing longitudinal unbalancedness. The data were analyzed in 3 ways. First, a two-stage procedure fitted linear regressions on age to each lamb at the first stage. Subsequently, the least-squares estimates (intercept and slope) were described with a

bivariate linear model having effects of sex of lamb and ration; least-squares estimates were assumed bivariate normal, and independent between lambs, but with a 2×2 covariance structure within animals. The second analysis fitted a longitudinal mixed effects linear model, with fixed effects of sex and ration and random effects of lamb. The variance-covariance matrix of lamb-specific regression coefficients was estimated by REML; effects of sex and ration were estimated using empirical best linear unbiased estimation. A Bayesian linear mixed-effects model (as in the second analysis) using Gibbs sampling and flat priors for all parameters was undertaken as well. The last two procedures are more efficient, since the two-stage method introduces extra variability in parameter estimation. Likelihood-based and the Bayesian method gave similar results, except for (co)variance components. The Bayesian procedure takes into account uncertainty about all parameters in the model, producing more satisfactory finite-sample inference.

Key Words: Longitudinal data, Mixed model, Lamb growth

621 Dietary betaine does not effect whole body palmitate oxidation. D. Wray-Cahen^{*1}, T.J. Caperna², E. Virtanen³, and N.C. Steele², ¹FDA/CDRH, Rockville, MD, ²USDA/ARS, Beltsville, MD, ³Finnfeeds Intl., Wiltshire, UK.

Dietary trimethylglycine (betaine, BET) is associated with reduced carcass fat in the growing pig. We explored potential effects of BET on fatty acid oxidation and metabolism during intravenous infusion of $1\text{-}^{13}\text{C}$ -palmitate (PA). Pigs (55 kg BW, n=6) were fed one of three diets containing 0% BET (control), 0.125% BET or 0.5% BET at 80% of *ad libitum* energy intake. Diets were corn-soybean meal-based and contained 17.6% crude protein and 3.27 Mcal ME/kg; experimental diets were fed for one week before initiation of infusion studies. Animals were catheterized to allow for simultaneous sampling and infusion. PA was complexed to methyl- β -cyclodextrin (MBC) for intravenous infusion. After priming the pigs with ^{13}C -bicarbonate, the PA/MBC complex was infused into pigs under steady-state fed conditions for 4 h at $0.7 \mu\text{mol/kg/h}$. The control and 0.5% BET pigs were also studied under fasted conditions (n=5). Metabolism and oxidation of infused PA were determined by breath or blood $^{13}\text{CO}_2$ -enrichments. CO_2 (IRMS) and palmitate (GCMS) isotopic enrichments were determined by mass spectrometry. Under steady-state fed conditions, palmitate oxidation was 0.163 ± 0.14 , 0.144 ± 0.030 , $0.163 \pm 0.034 \mu\text{mol/kg/min}$ for control, 0.125% BET, and 0.5% BET pigs, respectively; dietary treatment had no effect on oxidation ($P > 0.1$). Fasting increased overall oxidation rates by 7-8 fold in both the control and 0.5% BET groups ($P < 0.01$), but fasting oxidation rates were similar ($P > 0.1$) between these dietary treatment groups. Under these experimental conditions, dietary BET had no apparent effect on whole body fatty acid oxidation either in the fed or fasted state and therefore the reduction in adipose accretion must be via another mechanism. Supported in part by Finnfeeds Intl.

Key Words: Betaine, Palmitate oxidation, Lipid metabolism

622 Effects of betaine on nutrient partitioning in feed-restricted pigs. I. Fernandez-Figares^{*1}, D. Wray-Cahen², N.C. Steele¹, R.G. Campbell³, D.D. Hall⁴, E. Virtanen⁵, and T.J. Caperna¹, ¹USDA/ARS, Beltsville, MD, ²FDA/CDRH, Rockville, MD, ³BMI, Gridley, IL, ⁴United Feeds, Sheridan, IN, ⁵Finnfeeds Intl., Wiltshire, UK.

Dietary betaine (BET) is associated with decreased lipid deposition and altered protein utilization in pigs. Recent reports have suggested that substantial positive effects of BET on feed efficiency are greater in energy-restricted pigs. The purpose of this study was to examine the effects of BET on growth and body composition in young feed-restricted pigs. Thirty-two Landrace x York barrows (36 kg, n=8 pigs per group) were fed one of four corn-soybean meal-skim milk based diets containing 0, 1.25, 2.5 or 5g/kg BET. Pigs were fed at 73% *ad libitum* (ARC) and feed allowance was adjusted weekly according to body wt. At 64 kg, pigs were electro-stunned, exsanguinated and organs were removed and weighed. Carcasses were chilled for 24 h at 4C to obtain carcass measurements. Fat depths along the midline and at P1, P2, P3 sites at 10th rib were determined. One half of each carcass and total viscera (VIS) were ground for chemical analysis (H_2O , fat, protein, and ash). ADG was 475, 472, 501 and 499 g/d (PSE=23) for pigs consuming 0, 1.25, 2.5 or 5g/kg BET, respectively. Compared to controls, pigs consuming .5% BET had 9.8% less carcass fat, (481 vs 434 g/kg DW, PSE=20, $P < 0.05$); fat depth at P3 was 26% lower in .5% BET pigs ($P < 0.08$). Carcass protein: fat ratio was 0.96 for controls and 1.13 for

.5% BET pigs (PSE=.09, $P < 0.10$) and carcass protein deposition rate was enhanced by 17% ($P < 0.10$) in .5%BET pigs, compared to controls. Linear regression analysis indicated a positive linear association between BET level and carcass lean gain efficiency ($P < 0.13$) while negative linear trends for small intestine wt ($P < 0.11$) and total VIS wt ($P < 0.13$) were noted. These data suggest that BET alters nutrient partitioning in feed-restricted pigs such that protein deposition is enhanced at the apparent expense of carcass fat and in part, VIS tissue. Supported by Finnfeeds Intl. and NATO Science Fellowship (IF-F).

Key Words: betaine, body composition, pigs

623 Effect of yeast culture in calf starters fed to Holstein heifer calves. P.C. Hoffman^{*1}, G.J. Swart¹, J.E. Garrett², and A.J. Nytes³, ¹University of Wisconsin, Madison, ²Diamond V Mills, Cedar Rapids, IA, ³Vita Plus Corp., Madison, WI.

Eighty Holstein heifer calves (age = 1 d) were allocated to one of two dietary treatments. Calves were offered a commercial calf starter with (Yeast) or without (Control) 10 g/kg of Diamond V XP Yeast Culture ad libitum for 49 d. Calves were allocated to treatments over a 30 d period and were housed in individual calf hutches. Calves were fed 5.0 l/d of pasteurized waste milk in two equal feedings. Calf starters (Yeast and Control) were offered ad libitum starting d 2 until d 49. Calves were weaned when they consumed 900 g of calf starter for 3 consecutive days. Intake of calf starter was recorded weekly. Body weight (BW) of calves was recorded at entry, weaning, and at 49 d. Data were analyzed as a completely randomized design using ANOVA procedures of SAS. Two calves were removed from the trial due to health problems unrelated to treatment. Calves fed Control were weaned earlier (43.3 vs 45.9 d; $P < 0.05$) as compared to calves fed Yeast. Inclusion of yeast culture in calf starters reduced ($P < 0.03$) 49 d starter intake (20.9 vs 26.6 kg). There were no differences in BW at weaning, BW at 49 d, average daily gains, or feed efficiency between calves fed Control or Yeast. Data suggest yeast culture inclusion in calf starters decreased starter intake and increased weaning age. Mechanisms explaining these observations are unavailable at this time.

Item	Control	Yeast	SE	$P <$
Begin BW, kg	40.3	40.5	0.92	0.39
Weaning Age, d	43.3	45.9	1.02	0.05
Weaning BW, kg	64.2	65.5	1.07	0.67
49 d BW, kg	69.3	67.6	1.61	0.12
49 d ADG, g/d	590	554	28.6	0.22
Starter Intake, kg	26.6	20.9	2.39	0.03

Key Words: Yeast, Calves, Starter

624 Effect of Lean Growth Rate on Puberty Attainment of Gilts. J. L. Patterson^{*1}, R. O. Ball¹, H. J. Willis², F. X. Aherne², and G. R. Foxcroft¹, ¹University of Alberta, Edmonton, Alberta, ²Alberta Agriculture, Food and Rural Development, Edmonton, Alberta.

The current trend in the production of market pigs places emphasis on lean tissue growth rate. However, it is unclear how high lean growth rate impacts sexual development of gilts. One hundred sixty-eight pre-pubertal Genex Manor hybrid F1 gilts were used to examine the effect of lean growth rate on the attainment of puberty. At approximately 96 d of age and 54 kg weight, gilts were allocated with respect to growth rate and litter origin to one of two dietary treatments: 1) a diet formulated to optimize lean growth rate (O; n=84) 2) a diet producing normal lean growth rate (N; n=84). All gilts were fed treatment diets ad libitum and housed in groups of six. Weight, backfat and loin depth, and feed intake were measured weekly. Starting at $134.7 \pm .26$ d (mean \pm sem) of age, gilts received 20 min direct exposure to a vasectomized boar daily as a pen group for pubertal stimulation. Puberty attainment was determined as the day gilts first exhibited the standing reflex in response to contact with a boar. At pubertal estrus, body weight, backfat and loin depths were recorded. Diet affected ($P \leq .05$) weight (O, $73.7 \pm .3$; N, $71.2 \pm .3$ kg), growth rate (O, $.63 \pm .002$; N, $.61 \pm .003$ kg/d), loin depth (O, $44.0 \pm .3$; N, $41.7 \pm .3$ mm), fat depth (O, $12.3 \pm .2$; N, $11.6 \pm .2$ mm) and estimated lean growth rate (O, $.37 \pm .003$; N, $.35 \pm .003$ kg/d) during the growth period (start to stimulation). Feed consumed over the growth period differed ($P \leq .10$) (O, $2.5 \pm .05$; N, $2.6 \pm .05$). Of the 160 gilts completing the trial, only five did not reach puberty by 200 d. Diet did not affect age at puberty (O, 158.6 ± 2.0 ; N, 158.5 ± 2.0)

or days to puberty (O, 28.4 ± 2.0 ; N, 28.3 ± 2.0). Litter origin affected age at puberty ($P=.02$) and days to puberty ($P=.002$). Results indicate that observed differences in lean growth performance during prepubertal development had no effect on the age at puberty in O and N gilts, nor was overall lean growth rate at stimulation associated with pubertal age ($r=.001$ $P=.75$).

Key Words: Gilt, Puberty, Growth

625 The importance of a high feed intake during lactation of primiparous sows nursing large litters. J.J. Eissen¹, J.W.M. Merks^{*2}, M.W.A. Verstegen¹, and K.H. de Greef³, ¹Wageningen Institute of Animal Sciences, Wageningen University, Wageningen, The Netherlands, ²IPG, Insitute for Pig Genetics B.V., Beuningen, The Netherlands, ³Institute for Animal Science and Health, ID-Lelystad, Lelystad, The Netherlands.

The objective of this study was to investigate the effects of nursing a large number of piglets on lactation and post-weaning performance of primiparous sows and whether a larger feed intake can prevent possible negative effects. Data were recorded on 307 ad libitum fed sows of three genotypes in an experiment where litter size was standardized to 8, 11 or 14 piglets during a four-week lactation. Sows were fed ad libitum from day 10 after farrowing and piglets had no access to creep feed during lactation. Daily feed of sows was not affected by litter size for two genotypes, whereas it was curve-linearly affected for the third genotype ($P<.05$) with a maximum at 10.8 piglets. Backfat thickness loss of the sows increased linearly with litter size ($P<.05$) for two genotypes. In the third genotype backfat loss increased only at large litter sizes >9.8 piglets ($P<.01$). Body weight loss of the sow and litter weight gain increased linearly with litter size ($P<.001$). Differences in responses to increasing litter size found between the three genotypes may be related to differences in feed intake pattern during lactation, upper critical temperature and body composition of sows. Sows nursing more piglets during lactation had a higher probability of a prolonged weaning-to-estrus interval. A higher feed intake during lactation reduced tissue loss of the sow, increased litter weight gain ($P<.01$) and reduced the probability of a prolonged weaning-to-estrus interval. At high levels of litter size, a one-kg increase in feed intake resulted in a lower output, measured as reduced body tissue loss or increased litter weight gain, compared with low levels of litter size. This may be related to higher maintenance

627 Correlation of real-time ultrasonic measurement of longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. R. L. Dobec^{*}, M. L. Borger, and D. B. Foye, *The Ohio State University Agricultural Technical Institute, Wooster.*

The primary objective of this study was to estimate the relationship of real-time sonar measurements of fat depth and longissimus muscle area of thoroughbred horses with lifetime earnings and average earnings per win. Mares with racing records at the Keeneland 1998 November sale ($n=44$) were randomly selected and scanned for longissimus muscle area (LEA) and center loin fat depth (BR) posterior to the last rib (18th rib). An Aloka 500V console (Animal Ultrasound Services, Inc. Ithaca, N.Y.) with a 17.0 cm 3.0 megahertz linear probe was used for scanning. Age, earnings, average earnings per win, and total wins were obtained from catalog data. Longissimus muscle tracing and loin fat depth measurement were estimated using the Critical Vision Technology (CVT). Data were analyzed using SAS. Correlations of LEA with lifetime earnings and average/win were .18 and .13. The value of LEA as a predictor of racing success was significant ($p<.04$). Mean LEA for this study was 23.4, std. dev. = 2.2. There was enough relationship to racing ability to merit further research with larger sample size.

Key Words: Racehorses, Thoroughbred, Ultrasonics

628 Tibial optical bone density is positively correlated with bone strength. K.L. Waite^{*}, B.D. Nielsen, D.S. Rosenstein, and K.D. Roberson¹, *Michigan State University, East Lansing.*

Radiographic photodensitometry is a non-invasive method of estimating optical bone density in the horse. There is concern in the equine research community, however, that optical bone density is not correlated

requirements of sows due to heat stress and (or) less optimal conditions for piglet weight gain at high levels of litter size. Selection for a larger feed intake during lactation and improvement of environment and diet factors to reduce occurrence of heat stress is recommended.

Key Words: Feed intake, Primiparous sows, Litter size

626 Effect of increasing nutrient intake to sows from day 28-56 of gestation on subsequent progeny performance. P.C. Penny^{*1}, M.A. Varley², and S. Tibble³, ¹JSR Healthbred Ltd, Southburn, UK, ²SCA Nutrition Ltd, Thirsk, UK, ³SCA Iberica S.A. Mequinenza, Espana.

Utilisation of consumed feed from 40-100 kg BW and its conversion into pig growth is a major determinant of efficient pig meat production. Targeting specific time windows during gestation can potentially influence lean tissue deposition in subsequent progeny via changes to foetal development. The objective of this study was to examine the effect of increased nutrient intake during day 28-56 of gestation on progeny growth from weaning to slaughter. Twenty four multiparous sows (JSR Genepacker 90) were randomly allocated between two treatments, Standard (ST) 2.5 kg/d or Elevated (EL) 5.0 kg/d from d 28-56 of gestation. Three boars and gilts were weaned from each sow and were housed in groups of twelve from d 58 to slaughter. All pigs received identical nutrition and were weighed on d 58, 93, 128 and 159. Quantity of feed consumed during gestation was lower ($P<.01$) for ST than EL sows (322 vs 383 kg). There were no differences for born alive, litter weight at birth and weaning, or average daily feed intake (ADFI) between ST and EL sows. No significant performance response was observed from weaning to d 93. ST progeny produced a significantly lower average daily gain (ADG) from d 93-128 ($P<.05$) compared to progeny from EL fed sows (0.697 vs 0.743 kg). Gain/Feed (G/F) for ST progeny was also substantially reduced ($P<.05$) during this same time window (0.38 vs 0.41). Rib lean measurement (52.3 vs 54.4 mm) showed a positive response ($P<.08$) towards those progeny from EL fed sows. These results suggest performance benefits are obtainable from progeny which have been derived from sows that have received increased maternal nutrients during a specific foetal development window.

Key Words: Sows, Gestation, Performance

HORSE SPECIES

with bone strength. The objective of this study was to determine the correlation between optical bone density as determined by radiographic photodensitometry and bone strength. The hypothesis was that there is a significant positive correlation between optical bone density and bone strength. Tibiae, humeri and femurs were removed from turkeys euthanized as part of a separate study. Dorso-palmar radiographs were taken (57 KV, 400 mA, 4 msec, 1.6 mAs) to determine radiographic bone aluminum equivalence (RBAE). An aluminum stepwedge penetrometer was exposed with each radiograph as a standard. Radiographs were scanned at two locations on the bone and logarithmic regression was used to determine the lateral and medial RBAE using the thickness of the stepwedge and the maximum optical bone density readings of these cortices. Total RBAE was determined using the total area of the bone divided by the total area of the stepwedge. Shear tests were conducted with a double block test fixture designed to exert a shear force on a 5 mm section of the mid-diaphysis of each bone, with a load rate of 5 mm/min. Correlations between RBAE (mm^2) and load (N) were calculated using the correlation procedure of SAS (6.12). There was no correlation between RBAE and strength in any of the femur and humerus measurements taken. No difference was found between tibial RBAE taken at the mid-diaphysis or the nutrient foramen, and tibial data were pooled. Total tibia RBAE was correlated with bone strength ($r=.56$, $P=.0009$), as was medial RBAE ($r=.47$, $P=.0073$) and lateral RBAE ($r=.56$, $P=.0009$). These data suggest there is a positive correlation between optical bone density and bone strength in the tibia and support radiographic photodensitometry as an effective, non-invasive means of detecting potential differences in bone strength in the live animal.

Key Words: Radiographic photodensitometry, Bone strength, Correlation

629 Effects of Matua hay on gestating and lactating mares and their foals. K. A. Ball¹, H. A. Brady¹, V. G. Allen¹, K. R. Pond¹, and M. L. Galyean¹, *Texas Tech University*.

The use and safety of Matua bromegrass (*Bromus willdenowii*) has not been documented previously for use in diets of gestating and lactating mares. Objectives were to evaluate effects of Matua hay on intake, gestational length, foal weights, milk composition and reproductive parameters compared to alfalfa (*Medicago sativa* L). Eight, 3-yr old and four, aged (7 to 12-yr old) gravid mares were used. Days on trial pre-partum for each mare were variable (mean 59 d), but all mares were on trial 70 d post-partum. Mares were blocked by age, expected foaling date, and weight, and were assigned randomly to either Matua or alfalfa treatments (n=6 per treatment). Mares were individually fed at 2% of BW pre-partum, and increased to 3% of BW post-partum. Diet ratios were 1.5% of BW hay and 0.5% of BW concentrate pre-partum, and 1.55% of BW hay and 1.45% of BW concentrate post-partum. Refusals were collected every 24 h; if all feed was consumed, the feed allowance was increased 0.10% of BW. Mares were weighed every 2 wk until 70 d post-partum. Crude protein averaged 15.1% for Matua and 20.4% for alfalfa. No negative effects were observed from feeding Matua hay. Dry matter intake of forage averaged 6.8 kg/d for Matua and 7.0 kg/d (SE= 0.4) for alfalfa pre-partum. Post-partum intake averaged 7.9 and 8.3 kg/d (SE=0.7) for Matua and alfalfa respectively. Mean gestational length of mares fed Matua (342.4 d) did not differ from those fed alfalfa (340.7 d). Neither foal birth weights nor average daily gain differed between the two treatments. Live foal births were 100% for each treatment. The difference of percentage protein in milk between treatments depended on day of sampling; percent protein on day 1 was lower in milk from the alfalfa treatment ($P < 0.03$). Throughout the remainder of the trial, milk protein decreased similarly in both treatment groups. Our results suggest that Matua is a satisfactory hay for mares during late gestation and early lactation.

Key Words: Matua, Gestation, Lactation

630 Nutrient utilization of various grasses by grazing horses. L. A. Vogedes*, H. S. Hussein, J. P. Tanner, H. Tokuyama, and H. Han, *University of Nevada, Reno*.

The objective of this study was to determine the effects of forage species on digestibility of nutrients by grazing horses. Eight geldings (Quarter Horse; averaging 455 kg in weight and 14 years in age) were used in a 3 x 3 Latin Square Design experiment (3 treatments in 3 experimental periods [2 weeks each]). Treatments were pastures of 3 forage species (i.e., tall fescue [*Festuca arundinacea*], orchardgrass [*Dactylis glomerata*], and ryegrass [*Lolium perenne*]) at similar initial stage of maturity (i.e., vegetative stage). Two or three horses were assigned randomly to graze each pasture and were rotated every two weeks to the other pastures. Each experimental period included one week adaptation to the forage species to be grazed and one week for daily collection of forage (clip) and fecal (total) samples. Daily forage DM intakes were estimated from digestibility of DM (from concentrations of ADL in forage and feces) and total fecal DM output. Results indicate that horses are able to utilize orchardgrass more efficiently than tall fescue or ryegrass which appear to be utilized at the same efficiency.

Item	Tall fescue	Orchardgrass	Ryegrass	SEM
DMI, kg/d	9.67 ^b	10.20 ^{a,b}	10.72 ^a	.33
Digestibility (%)				
DM	48.93 ^b	59.07 ^a	49.26 ^b	.98
OM	53.17 ^b	62.47 ^a	53.01 ^b	.99
CP	64.91 ^b	71.46 ^a	60.10 ^b	1.66
NDF	42.30 ^c	51.57 ^a	44.95 ^b	.81
ADF	38.60 ^c	48.47 ^a	42.57 ^b	.66
Cellulose	54.30 ^c	62.98 ^a	57.25 ^b	.82
Hemicellulose	49.31 ^b	57.48 ^a	49.73 ^b	1.54

^{a,b,c} Means with uncommon superscripts differ ($P < .05$).

Key Words: Horses, Forages, Nutrient utilization

631 Michigan 4-H Horse Judges Program Exhibits Quality and Continuing Education. S.A. Doumit* and C.G. McLachlan, *Michigan State University, East Lansing*.

The Michigan 4-H Horse Program has offered a list of horse judges to its industry for over 25 y. The program has evolved to a system that offers 125 educated, quality evaluators that are required to maintain an active 4-H show judging profession and attendance at educational workshops and seminars. The primary objective is to provide a quality source of judges to the Michigan horse industry, educated in a variety of disciplines, emphasizing the development of life skills through horses. The program is maintained in philosophy and education by the Equine Extension Youth Specialist and Michigan 4-H Horse Judges Advisory Committee. Record keeping and file maintenance is serviced in the Extension Specialists office. Potential applicants are sent a package including a cover letter, guidelines for judges, a description of qualities desired in judges, recommendation forms, a preparation sheet, a current judges list, judges evaluation forms for applicants, and the application. Once applications are received, applicant files are reviewed and those qualified are selected for personal interviews. When applicants are selected to enter the program, most are placed on a Conditional List. This is a provisional list where the judges performance is evaluated by assigned current senior judges. If conditional judges receive ratings to advance to the regular list, they are advanced and expected to maintain good standing. Good standing status includes having judged 3 shows in 2 y, attending the Michigan 4-H Horse Judges and Superintendents Conference once every 3 y, and attending an approved clinic annually. This maintains quality judges that are being educated in subject matter and youth development. The list is distributed to Michigan county extension offices, Michigan judges, and anyone requesting the list. The list is a resource providing educated evaluators helping to ensure quality in Michigan's 4-H Horse Program. The program is currently involved in a multi-state equine alliance in the midwest reviewing each states programs and creating opportunities to potentially streamline programs and create new regional opportunities for the industry.

Key Words: Horse, Youth, Judge

632 Identification of the toxic compounds in *Acer rubrum*. J Boyer*, D Breeden, and D Brown, *Cornell University, Ithaca, NY*.

Wilted or dried red maple leaves are toxic to horses, and when ingested cause oxidative damage resulting in methemoglobin formation, hemolytic anemia, and often death. This study identified the toxic compounds found in wilted red maple leaves. An in vitro assay was used to measure the amount of equine methemoglobin formed by exposure to maple leaf extract and fractions obtained by thin line chromatography (TLC). Four hundred μ l of maple leaf extract were spotted on a silica gel plate, and the plate was developed in an ethyl acetate:methanol:water (100:13.5:10) solvent system. Each identified band was scraped from the TLC plate and extracted with methanol. After evaporating off the methanol, each fraction was placed in 250 μ l of equine blood and incubated for two hours. The compounds from the band with an Rf of .46 - .54 caused a significant amount of methemoglobin formation (35%, $p < .001$). The compounds from the active band were analyzed using gas chromatography and mass spectrometry (GC/MS). A significant peak from both the active TLC fraction and the red maple leaf extract occurred at 8.1 minutes and was identified by mass spectrometry as 1,2,3-trihydroxybenzene, more commonly known as pyrogallol. Further gas chromatographic analysis revealed that the concentration of pyrogallol in the maple leaf extract was .55 mg/ml extract. When 200 μ l of a .55 mg pyrogallol/ml methanol solution were added to 500 μ l of equine blood and incubated for two hours, 42% of the total hemoglobin was oxidized to form methemoglobin. Silver maple (*Acer saccharinum*), sugar maple (*Acer saccharum*), and Norway maple (*Acer platanoides*) extracts also resulted in methemoglobin formation in the in vitro assay. GC/MS analysis indicated that these leaves contained pyrogallol, but in lower concentrations than in the red maples. Based on these results, pyrogallol appeared to be the major oxidative compound in red maple leaves. The role of other compounds in the active TLC fraction is still under investigation.

Key Words: *Acer rubrum*, Horses, Poisonous plants

633 Dose dependent decrease in feed intake following intravenous injection of urocortin into pony mares. P. R. Buff^{*1}, N. C. Whitley², E. L. McFadin-Buff¹, and D. H. Keisler¹, ¹University of Missouri, Columbia, ²University of Maryland-Eastern Shore, Princess Anne.

Our objective was to determine if intravenous injection of urocortin would alter feed intake and serum cortisol concentrations in ponies. Ten jugular vein - cannulated pony mares averaging 257.7 \pm 6.6 kg BW were used in two experiments (Exp). After an overnight fast (18 hours), ponies were randomly chosen for intravenous injection of 50 μ g/pony (Exp 1) or 5 μ g/kg BW (Exp 2) rat urocortin or an equivalent volume of saline (treatment = time 0). Thirty minutes after treatment (and at times when feed intake was measured) ponies were given their usual ration of alfalfa pellets in 300 g increments, such that each pony had feed present at all times. Cumulative feed intake was determined by weighing the amount of unconsumed feed at 50, 80, 110, 140, 200, and 350 minutes after treatment and was expressed as g/kg BW, so as to account for differences in pony body weights. Blood samples were collected every 10 minutes from -20 to 30 minutes and then at 30, 60, 90, 120, 180, 240, and 360 minutes after treatment. Serum concentrations of cortisol were assessed at times 0, 30, 60, 120, 240, and 360 min in samples collected during both replications from 7 randomly selected ponies. In Exp 1, cumulative feed intake was influenced by a treatment by time interaction ($P < .0003$) in which feed intake was lower ($P < .02$) beginning 110 min after urocortin compared to saline treatment. However, in Exp 2, cumulative feed intake was not influenced by treatment. Serum concentrations of cortisol were influenced by urocortin in both Exp 1 and 2 (treatment by time period interactions, $P < .0008$). Cortisol was greater ($P < .005$) at 30, 60, and 120 min after treatment compared to saline for both Exp 1 and 2. In these studies, intravenous injection of urocortin decreased feed intake dependent upon dose, but increased cortisol regardless of dose. In conclusion, urocortin may modulate food intake independently of serum cortisol in pony mares and therefore may be a potential tool for managing obesity in horses.

Key Words: Urocortin, Horse, Feed intake

634 Fecal output, digestibility and pasture intake predicted by marker methods in grazing horses. J.L. Holland^{*1}, D.S. Kronfeld¹, W.L. Cooper¹, and P.A. Harris², ¹Virginia Polytechnic Institute and State University, Middleburg AREC, Middleburg, ²Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leics, UK.

Marker methods have provided accurate and precise estimates of fecal output (FO), dry matter digestibility (D), and dry matter intake (DMI) in stalled horses. These methods needed to be validated in grazing horses. Two groups of 4 Thoroughbred geldings were placed on bluegrass/white clover (BC) and tall fescue/alfalfa (FA) pastures in a replicated 2x2 Latin Square design. Balance experiments were conducted in 15 d periods with a 14 d diet accommodation prior to the beginning of balance experiments. The external marker, Cr, was administered in "greenola bars" containing 6.0 \pm .5 g Cr/bar, at 0700, 1300 and 1900 each day for 8 d. Dry matter, Cr, and yttrium (Y) were analyzed in pasture and fecal samples using AOAC procedures. Alkane concentrations in pasture and feces were analyzed using gas chromatography. Daily fecal concentrations of Cr (C_t , g/kg DM) were fit to a simple mono-exponential equation with one rate constant (k) rising to an asymptote (C_a). Equations included a delay (d), which represented the time needed for Cr to enter the pre-fecal pool. Delays were 4.7 h and 5.4 h for BC and TA respectively. Yttrium and odd-chain alkanes were evaluated as internal markers to estimate D. Fecal output was measured in geldings with total fecal collection harnesses, and was estimated by the following equation $FO = Cr \text{ dose } (d^{-1}) / C_a$. Fecal output was used in combination with D predictions to estimate DMI: $DMI = FO / (1 - D)$. Yttrium gave higher estimates of D than previously reported, and alkanes gave lower D values than expected. Fecal output estimated from C_a gave values similar to weighed FO ($P > .20$). When estimated D from Y was used with either TC or estimated FO to predict DMI, the predicted intake was approximately 3.3% of BW. These results encourage further development of marker methods for estimating FO, D and DMI in grazing horses.

Key Words: Horse, Marker methods, Pasture

635 Glycemic response in thoroughbred mares fed a high fat and fiber or high sugar and starch pasture supplement. C.A. Williams^{*1}, D.S. Kronfeld¹, W.B. Stanier¹, and P.A. Harris², ¹Virginia Polytechnic Institute and State University, Middleburg AREC, Middleburg, ²Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, Leics, UK.

A study was conducted to evaluate the glycemic response in two groups of six Thoroughbred mares at three stages (late gestation, and early and late lactation), one group fed a traditional sweet feed high in sugar and starch (SS), the other a feed high in fat and fiber (FF). The SS and FF supplements had similar DE (3.5 to 3.8 Mcal/kg) and CP (14 to 16%), but differed in fat (3.3 and 16.4% respectively), and NDF (18 and 36%, respectively). Mares were placed in stalls and fasted overnight (12 to 18 h). Blood was collected via a venous catheter at -30, 0, 30, 60, 120, 180, 240, 300 and 360 min after feeding 1.8 kg of feed. Baseline values, peak values and area under the curves (AUC) were evaluated as least squares means and standard errors. The mean baseline plasma glucose and insulin concentrations were similar for both groups at every stage being 4.0 \pm 0.2 mmol/l and 5.3 \pm 0.3 IU/l, respectively. During late gestation, and early and late lactation the plasma glucose peak was higher in SS than in FF ($P = .021$, $P = .002$, and $P = .048$, respectively). Peak insulin concentrations were higher in SS than in FF during early ($P = .006$) and late ($P = .009$) lactation, however there was no difference during late gestation. Glucose AUC's were higher in SS than in FF during late gestation ($P = .036$), early ($P = .0002$) and late ($P = .009$) lactation. Insulin AUC's were higher in SS than in FF during early ($P = .008$) and late ($P = .008$) lactation, but similar for late gestation. These data indicate that mares fed the FF supplement had a reduced glucose and insulin response compared to mares offered the SS supplement. Therefore, feeding a higher fat diet to mares throughout gestation and lactation may reduce the risk of certain digestive and metabolic disorders such as osteochondrosis, colic, rhabdomyolysis and laminitis, which may be linked to a pronounced glycemic response.

Key Words: Horse, Plasma glucose, Plasma insulin

636 Equi-SiTM increases plasma and milk silicon levels and alters bone and collagen metabolism in horses. K. J. Lang^{*}, B. D. Nielsen, M. W. Orth, G. M. Hill, H. C. Schott, and K. L. Waite, Michigan State University, East Lansing.

Supplemental silicon (Si) enhances bone and collagen metabolism in rats and appears to decrease the occurrence of bone related injuries in racing Quarter Horses. Thus, Si may alter bone metabolism in horses. Our objectives were to determine if supplemental Si: 1) increases plasma and milk Si concentrations and 2) alters systemic markers of bone and collagen metabolism. Twelve Arabian mare/foal units were randomly assigned to: control (C) and Equi-SiTM (Si source) treated (S). All mares were fed to meet NRC requirements (1989). The S group was fed Equi-SiTM, at 2.0% of the diet, starting the first day after parturition. Blood samples from all mares and foals and milk samples were taken on d 0, 15, 30 and 45 following parturition. Plasma and milk were analyzed for Si concentrations, and serum was analyzed for osteocalcin (OC), carboxy-terminal pyridinoline cross-linked telopeptide region of type I collagen (ICTP), and pyridinoline and deoxypyridinoline (PYD). Mares treated with S had higher plasma Si levels than C mares on d 45. Mares in the S group tended to show higher OC values ($P = .07$) on d 30 and d 45 and lower PYD values ($P = .08$) on d 30 than C mares. In a second experiment, with 20 yearlings (10 Arabians and 10 Quarter Horses), five of each breed were S treated (2% of the diet as Equi-SiTM), and the remaining yearlings served as controls. Blood samples were taken on d 0, 15, 30 and 45, and were analyzed for plasma Si levels and OC, ICTP and PYD. Yearlings treated with S had increased plasma Si levels on d 15, 30 and 45, relative to d 0. Also, treated yearlings had lower ICTP levels on d 45 than C yearlings. Thus in both studies, Equi-SiTM increased plasma and milk Si concentrations. In conclusion, Equi-SiTM may alter bone and collagen metabolism by enhancing bone formation and decreasing collagen degradation.

Key Words: Horses, Silicon, Bone Metabolism

637 Glycemic response of mares fed a typical pelleted horse feed. W. B. Staniar*¹, C. A. Williams¹, D. S. Kronfeld¹, and P. A. Harris², ¹Virginia Polytechnic Institute and State University, Blacksburg, VA USA, ²Equine Studies Group, WALTHAM Centre for Pet Nutrition, Melton Mowbray, UK.

Responses of plasma glucose, triglycerides, cholesterol, and insulin were examined in twelve late gestational mares after being fed a meal of a typical pelleted horse feed. Mares were accommodated to this product for 3 months. They were deprived of feed but not water for 12 h prior to the glycemic response test (GRT). Baseline heparinized blood samples were taken via a jugular vein catheter prior to mares being fed a 2 kg. meal. Meals were consumed in 20-30 min and time zero samples were taken on all mares at 30 min, with subsequent samples at 30, 60, 120, 180, 240, 300, and 360 min. Plasma concentrations of glucose, triglycerides, and cholesterol were assayed by enzyme kits, insulin by a radioimmunoassay kit. Tukeys multiple-comparison procedure showed no differences between periods for triglycerides and cholesterol, and a difference between baseline and peak serum levels of glucose and insulin ($P = .05$). Baseline and mean serum levels of triglycerides were 23.5 ± 3.7 and 27.3 ± 1 mg/dl, respectively, and corresponding values for cholesterol were 92.4 ± 2.8 and $91.4 \pm .1$ mg/dl, respectively. Post-prandial insulin and glucose peaked at 60 min with a return to baseline at 360 min. Baseline and peak serum levels of glucose were 89.7 ± 9.6 and 164.2 ± 7.3 mg/dl, and corresponding values for insulin were 6.6 ± 2.1 and 47.0 ± 7.3 IU/l, respectively. These results were similar to those for other typical commercial pelleted or texturized horse feeds but substantially greater than responses to feeds rich in fat and fiber content. The latter type of feed may reduce the risk of disorders linked to high grain feeding.

Key Words: Equine, Glycemic Response, Insulin

638 The effect of fish oil supplementation on exercising horses. C.I. O'Connor*, L.M. Lawrence, A.C. St. Lawrence, and S. Hayes, University of Kentucky, Lexington.

Thirteen horses of Thoroughbred or Standardbred breeding were used to study the effect of dietary fish oil supplementation on exercising horses. Horses were assigned to either fish oil (FO, n=7) or corn oil (CO, n=6) treatment groups. The fish oil (Omega Protein, Hammond, LA) contained 11.3% eicosapentaenoic acid and 7% docosahexaenoic acid. All horses received timothy hay and a mixed grain concentrate at rates necessary to meet their energy needs. Oil was topdressed on the concentrate daily at a rate of 324 mg/kg BW. Horses were exercised 5 d/wk for 9 wk in a program of increasing intensity. Blood samples were obtained on d 0 (before supplementation), d 28 and d 63. Following the 9-week training period horses performed a standard exercise test on a high speed treadmill. The exercise test consisted of a 5-min warm-up at 1.9 m/s, 0% grade, followed by a step test on a 10% grade at incremental speeds of 2 to 8 m/s. Blood samples were obtained during exercise and recovery. Serum cholesterol and lipids decreased during conditioning ($P < .05$) and there was a time x treatment interaction ($P < .05$). Compared to horses receiving CO, horses receiving FO had lower serum lipids and cholesterol at week 4 ($P < .05$) and lower serum triglycerides at week 9 ($P < .05$). During exercise, heart rates were lower ($P < .05$) for horses receiving FO, but no differences in plasma lactate were detected ($P > .05$). Serum cholesterol was lower ($P < .05$) in horses receiving the FO treatment throughout exercise. Serum insulin and plasma free fatty acids were lower ($P < .10$) in horses receiving FO than in horses receiving CO during the initial stages of the exercise test (warm-up to 5 m/s). Plasma glucose was lower ($P < .05$) for the FO group during exercise recovery from 6 min to 30-min post exercise. Addition of fish oil to the diet altered plasma lipid characteristics of horses and may have affected insulin sensitivity and glucose metabolism in response to exercise.

Key Words: Horse, Fish Oil, Exercise

639 Forelimb kinematics and kinetics of the fox trot. M.C. Nicodemus*, J.L. Lanovaz, and H.M. Clayton, Michigan State University, East Lansing.

The temporal stride characteristics of the fox trot describe this gait as a fast, lateral sequence, diagonal couplets walk. Kinematic and kinetic analysis has not been applied, as to date, to the fox trot. Application of this analysis to other equine gaits has proven to be a valuable tool in the detection of lameness and the assessment of clinical treatments.

Therefore, this study measured the carpal and fetlock flexion/extension, forelimb vertical and cranio-caudal ground reaction forces, and vertical and left-right head displacement. Kinematics were tracked using reflective markers attached to the following locations of the right forelimb: 1) the joint centers of the elbow, fetlock, and coffin joints, 2) the distal and proximal aspect of the carpal joint, and 3) the cranial end of the wing of atlas (poll). Joint angles were measured on the caudal side of the joint. Four fox trotting strides performed by six Missouri Fox Trotters were recorded at 60 Hz and simultaneous sampling of the ground reaction forces were made with a Kistler force plate embedded into the runway matting. During the fox trot, the forelimb carpus and fetlock extend during the stance phase to 186 degrees and 225 degrees and flex during the swing phase to 116 degrees and 151 degrees, respectively. At 50 percent of the stance phase, the vertical ground reaction forces peak at 10.62 N/kg. During the first half of stance, breaking forces peak at -1.26 N/kg, and then, shift to a propulsive force at 65 percent of the stance phase where there is two force peaks with the first at .73 N/kg and the second at .67 N/kg. During forelimb impact, the head reaches maximum vertical displacement and has a total range of motion during the stride of 14 cm. During right fore impact, the head displaces to the left side of the body and at left impact displaces to the right side. Total range of motion in left-right displacement is 10 cm. These kinematic and kinetic measurements can be compared to the locomotion of forelimb lameness during the fox trot.

Key Words: Equine locomotion, kinematics, kinetics

640 Natural partners: Land grant universities and state horse councils. C.M. Brady*¹, M.A. Russell¹, P.J. Naile², and C. McCormick¹, ¹Purdue University, West Lafayette, IN, ²Indiana Horse Council.

The Indiana Horse Council (IHC) and Purdue University work closely together to provide better services to the Indiana horse industry. The Departments of Animal Sciences and 4-H Youth Development, and the School of Veterinary Medicine, are all involved in this collaboration, as well as the Indiana Horse Council Foundation. Each state has at least one land grant university with an extension mission, and most states have a horse council. Horse councils consist of members of the industry that work together, across breed and discipline, to educate and enact changes for the benefit of all members of the horse industry. The relationship between the universities and the horse councils may range from non-existent, to adversarial, to collaborative. The emphasis of the collaborative efforts of Purdue University and the IHC is in the offering of educational programs for horse industry participants. The School of Veterinary Medicine and the IHC annually co-host a Horseman's Conference. Attendance at the conference has increased from 50 in the first year (1998), to over 200 in 2000. Veterinarians from the SVM, as well as faculty and graduate students from the Departments of Animal Sciences, Agricultural and Biological Engineering, and 4-H Youth Development are featured speakers. The Department of 4-H Youth Development works closely with the IHC to provide 14 clinics and contests for more than 800 youth at the IHC's annual Hoosier Horse Fair. The Horse Council also supports the participation of 4-H teams qualifying for national contests in hippology, horse bowl, horse judging, public speaking, and demonstrations. Purdue University and the IHC have a truly collaborative relationship, where the two groups work together to identify needs in the industry, and then work together to meet those needs. This presentation will discuss not only existing programs, but describe the process which allows these two organizations to work together to benefit the Indiana horse industry.

Key Words: Horse Industry, Extension, State Horse Council

641 Using cooperative learning to teach horse science and management students with varying backgrounds. M.J. Wylie*, University of Wisconsin, Madison.

Horse Science and Management is a three credit spring undergraduate course with a typical enrollment of 20 to 30 students and no prerequisites. Students in the class represent varying backgrounds including both extensive and no horse experience. Approximately 60 to 65% are freshmen and sophomores with 35 to 40% being juniors and seniors. Approximately 50% are agricultural majors with other majors such as Spanish, Art, and Secondary Education not uncommon. Curriculum ranges from evolution and history of use to topics such as anatomy and physiology, feeds and nutrition, reproduction, genetics, behavior, and

exercise physiology. The challenge is to establish a common solid foundation of basic horse knowledge and build upon it. The non-science majors particularly need to learn basic biology as well as how it is applied to the horse. There is also a problem with dispelling horse folklore and learned misinformation. A questionnaire distributed at the beginning of each semester revealed that 40 to 50% considered their level of horse knowledge to be "Lots!" with 35% selecting "Moderate". Only 5% or less considered their knowledge level as either "Expert", "A Little", or "None". A "pre-course knowledge exam" completed by the students within the first week assesses the types of horse knowledge and experiences represented in the class. An experiential learning model of do-apply-reflect is used throughout the semester with cooperative learning a key technique. Group work causes the students to work together and maximize their own and each other's learning. Specific cooperative learning examples include the use of Think-Partner-Share and ways to deal with contrasting information and misinformation. This mix of teaching techniques meets the needs of different student learning styles. A "post-course knowledge exam" has indicated that basic horse science knowledge is improved and a final exam practicum allows students to demonstrate that they can apply what they have learned. Horses attract interest from a variety of students and once exposed to an animal sciences course, some may become interested in additional agricultural courses. Most important, these students now have an understanding of a domestic farm animal and an overall improved agricultural literacy.

Key Words: Horse Science, Cooperative Learning, Teaching

642 Integration of an equine program in an animal science curriculum: the minor degree approach. G. R. Galagher*, *Berry College, Mt. Berry, GA.*

Student interest has increased pressure toward incorporation or expansion of equine programs into traditional food animal production cur-

riculum. Successful integration of the equine program during a 10-year period into the animal science program at Berry College provides a case study of methodology. Prior to 1989, equine were utilized for physical education activity credit and a senior level horse production course. In 1989, 4 equitation related courses listed under animal science were developed. In the same year, an 8-member intercollegiate equestrian team began competing in the Intercollegiate Horse Show Association (IHSA). Equine minor degree programs open to all academic majors were introduced in 1993, despite pressure to develop an equine option in the animal science major or an equine major. In the same year the equestrian team had to be limited to 65-members due to popularity. Changes in student enrollment in the freshman introduction to animal science course increased 394% from 1988 (n=18) to 1998 (n=71). The equine minor provided a flexible curriculum allowing students to design their program based on interests including: science, business or recreation. The department benefited by increased teaching credit hours generated, recruitment and retention of students, and public relations. The college also benefited in recruitment and retention of students. A survey of species interest was completed by freshman students enrolled in the introductory animal science course fall 1998 (n=71). Students ranked in descending order of interest (7=greatest, 0=least): beef, dairy, domestic pets, horse, sheep, swine, poultry, wildlife/exotics. Mean responses for species interest were: horse (6.1), domestic pets (5.1), wildlife/exotics (4.1), dairy (4.0), beef (3.7), sheep (2.3), swine (1.9) and poultry (1.0). Results indicate a strong preference of freshman toward equine and domestic pets. In 1998, the department maintained 132 animal science majors, 45 equine minors and 15 animal science minors.

Key Words: Undergraduate, Equine, Minor degree

INTERNATIONAL ANIMAL AGRICULTURE

643 Genotype differences in heat-shock protein (Hsp70) expression in bovine lymphocytes exposed to temperature treatments. R. Banuelos-Valenzuela*¹, C. F. Arechiga¹, H. R. Vega-Carrillo², and S. H. Sanchez-Rodriguez², ¹FMVZ-Universidad Autonoma de Zacatecas, Zacatecas, Zac. Mexico, ²CREN-Universidad Autonoma de Zacatecas, Zacatecas, Zac. Mexico.

In order to determine whether heat-shock protein (Hsp70) expression could be a potential indicator of animal adaptation to harsh environments and environmental stress, the present study determined heat-shock protein (Hsp70) expression in response to four temperature treatments in bovine lymphocytes from different breeds (Holstein, Australian-Holstein, Brown Swiss, Limousin and Criollo). Lymphocyte viability was above 98% in all eight replicates performed. Constitutive expression of Hsp25, 60, 75, 90 was determined at 38 C (homeothermic temperature), but only Hsp70 was expressed in lymphocytes. Bovine lymphocytes were then exposed to temperature treatments of 40, 42 and 44 C during 4 h. Exposure of lymphocytes to 40 C induces a slight increase in Hsp70 expression and a maximum expression at 42 C in all five different cattle breeds. There were statistical differences in protein expression due to temperature treatments (P<0.05), but no difference among cattle breeds, and neither the interaction. However, there was a tendency for differences in Hsp70 expression among breeds in a decreasing pattern as follows: Australian-Holstein, Brown Swiss, Criollo, Holstein, and Limousin. In all five cattle breeds, Hsp70 expression decreased at 44 C (lethal temperature for lymphocytes). In conclusion, elevated temperature act as a source of stress for bovine lymphocytes inducing Hsp70 expression, however, further research is required to determine whether Hsp70 expression in bovine lymphocytes could be used as a precise indicator of adaptation to environmental stress in bovines from arid regions or whether Hsp70 expression is correlated with animal adaptation.

Key Words: Hsp70, cow, adaptation

644 Management of tropical pastures renovated using the Barreiro system. C. D. U. Magnabosco*¹, R. D. Sainz², A. O. Barcellos¹, I. P. Oliveira³, and D.O. Costa³, ¹Embrapa Cerrados, Planaltina,DF/Brasil, ²University of California, Davis, ³Embrapa Arroz e Feijão, Goiânia,GO/Brasil.

Three systems of renovation and management of degraded tropical pastures were compared during two years following renovation using the Barreiro system, which involves establishment of a pasture stand in association with an annual crop, in this case upland rice. System 1 was establishment of *Brachiaria decumbens*; systems 2 and 3 were establishment of *Brachiaria brizantha* cv. Marandu, without and with a protein bank (*Stylosanthes guyanensis* cv Mineiro). Each system was established on 6 ha blocks. Yearling bulls of several breeds (Nelore, InduBrasil, Santa Gertrudis, and Canchim (5/8 Charolais x 3/8 Nelore)) were allowed to graze each area during the dry and wet seasons. Paddocks were rotated in a 35 day cycle, and animal weights and available forage measured at each cycle. Carrying capacity was greater in year 1 (636, 740 and 868 kg/ha/yr) than in year 2 (365, 448 and 480 kg/ha/yr) for systems 1, 2 and 3, respectively. Average daily gains (g/d) were also higher (P<0.001) in year 1 (538) than in year 2 (458). However, there were no differences between breeds, or between high and low 365-day weight EPD groups within the Nelore animals. Total weight gains for each system were 393, 449 and 500 kg/ha in year 1 and 210, 254 and 260 kg/ha in year 2 for systems 1, 2 and 3, respectively. The decline in carrying capacity from year 1 to year 2 was expected, due to disappearance of residual fertilizer from the crop. However, the decline in average daily gains was likely due to an abnormally wet and cold rainy season, which had adverse effects on pasture growth and quality, and on animal performance. In addition, sire EPD for 365-day weight was expected to affect animal performance. It is difficult to draw conclusions from such a small sample, but the lack of effect may have been due to the generally low performance allowed by the environment. Nevertheless, this project is ongoing and further work should help to elucidate some of these interactions.

Key Words: Beef Cattle, Pasture renovation, Forage production

645 Sustainable use of mountain pastures by sheep in Switzerland. M. Schneeberger*, *Swiss Sheep Breeders' Association*.

The Alpine area is a complex and fragile ecological system, used by agriculture, tourism and recreation. The Swiss sheep population is 420.000 in total, 200.000 are pastured during summer for approx. 100 d in the Alpine area, 1600 to 2700 m above sea level. Thus, mountain pasture represents an important part of Swiss sheep production systems. Properly managed flocks have positive effects on landscape and reduce danger of avalanche damage to dwellings, roads and railway tracks. Insufficient flock and pasture management, however, can cause damage, i.e. erosions, loss of botanical diversity, and competition for feed with feral animals (chamois, ibex). Sustainable use of mountain pastures, thus, is essential. An interdisciplinary working party studied several mountain sheep pastures. Sheep have a tendency to follow the melting snow and overgraze the young plants, while lower parts of the pastures remain undergrazed. The elements of sustainable use of mountain pastures by sheep were elaborated; 1) Demarcation of the area to be pastured. In general, moderately steep country, covered by closed vegetation, is suited, whereas steep country, only partly covered by vegetation, and areas where grazing increases the danger of erosion are not suited for pasture. 2) System of pasture and flock management. Equal use of pasture can be achieved by permanently guiding flocks by a shepherd and sheep dogs. In most cases, however, this system is not feasible because of topography, and limited to large flocks for economical reasons. Similar results can be obtained by dividing the pasture in paddocks, delimited by natural boundaries or fences. The cost of putting up fences in mountain areas may be prohibitive. The only possible system often is free pasture, where sheep run free and select the location of grazing themselves. 3) Load of sheep, i.e. head per ha. This depends on elements 1) and 2). It varies with altitude, exposition and topography of the pasture. Conflicts between interests of environment conservation and agricultural utilization cannot be completely eliminated, they need to be weighed up according to the particular situation, differing from one farm to the next.

Key Words: Sheep, Mountain pasture, Switzerland

646 Effect of a synchronized-ovulation treatment in Hereford heifers at the beginning of a breeding program with bull sires and/or timed artificial insemination in North-Central Mexico. J. A. Ramirez-Chequer, R. de Leon-Medina, J. O. Enriquez, M. A. Castillo-Pecina, R. M. Rincon, R. Banuelos-Valenzuela, and C. F. Arechiga*, *FMVZ-Universidad Autonoma de Zacatecas, Mexico*.

A protocol for synchronized ovulation (SO= d 0, GnRH_a; d 7, PGF_{2a}; d 9, GnRH_a; d 10, breeding: bull sire or timed artificial insemination) was evaluated in Hereford heifers under two breeding systems: 1) natural breeding with bull sires (BS); 2) timed artificial insemination (TAI). The protocol was implemented and the number of pregnant heifers to first service above total number of heifers was determined (pregnancy rates). Hereford heifers (n=37; >200 kg; from "TULA" Ranch in Zacatecas), were included in a breeding program and exposed to a synchronized-ovulation treatment at two different months during the breeding season (may and august). In d 10, heifers were exposed to either: 1) breeding with bull sire (n=18); 2) breeding with timed artificial insemination for the first service (n=19), followed by breeding with bull sires for subsequent heats. During the first period of the breeding season (may), there were no pregnancies at the first induced ovulation. During the second period of the breeding season (august), 15.8% of the heifers (3/19) were pregnant in response to the synchronized-ovulation treatment (10.5% BS; 5.3% TAI) All pregnant heifers had >250 kg of BW). Pregnancy diagnosis by rectal palpation resulted in a total pregnancy rate of 46% by 180 d after the SO-treatment (17/37) (more pregnancies from following heats within the seasonal breeding of 120 d length). In conclusion, synchronized-ovulation programs can be also implemented in breeding programs with bull sires. Pregnancy rates were greater during the raining season (august), with heifers of greater body weight and with at least a corpus luteum at the beginning of the synchronized-ovulation treatment. Heifers bred with TAI required greater body weights than heifers bred with bull sires.

Key Words: beef heifer, timed insemination, bull sire

647 Manure Management in Dairy Systems: A China-State of Wisconsin Comparison. M.A. Wattiaux*¹, J.M. Powell², G.G. Frank³, and Z.G. Wu², ¹*The Babcock Institute*, ²*U.S. Dairy Forage Research Center*, ³*The Center for Dairy Profitability, University of Wisconsin, Madison*.

The objective was to compare efficiencies of manure N recycling through crops in contrasting dairy systems in China and Wisconsin. A multi-disciplinary team of scientists interviewed owners or managers of nine farms in China's southernmost province of Yunnan and northernmost province of Heilongjiang and collected data on livestock, crop, grassland, and manure management. The Chinese farms surveyed were located in different agroclimatic zones and differed in size (three to 320 cows), ownership and management style. For this reason, each farm was considered a case study. The data collected were compared to Wisconsin averages (Wisconsin Agricultural Statistics, 1999 and survey results of 93 farms). In Yunnan, the dairy system could be classified as landless because animals were kept in confinement all year and more than 90% of the estimated feed needed was purchased. This landless system was found in peri-urban farms and among small holders who used their land for rice and vegetable crops. Heilongjiang farms were classified as a mixed livestock-crop system in which corn silage served as the forage source during the winter and cows were grazed in communal pasture in summer. Dairy livestock density ranged from 2.2 to 20.9 animal units (one unit = 454 kg BW) per hectare of cropland in China, compared to the average of 1.5 in Wisconsin. Manure availability for cropland application ranged from 156 to 1,468 kg/hectare/yr in China, compared to the average of 104 kg/hectare/yr in Wisconsin. Overall, 12% of manure N was recycled through small holders' crops in Yunnan, as compared to 21% in Wisconsin, while in the peri-urban system 35 to 40% of manure N was captured and exported from the farm. The higher efficiency of the peri-urban system was associated with privatization of manure handling and marketing for vegetable crops. The overall risk of pollution through N loss to the environment was high, but varied considerably depending upon production systems and nutrient management strategies.

648 Evaluation of three different feeding systems for dairy calves in Mexicali, Mexico. J. S. Saucedo-Quintero¹, L. Avendano-Reyes*¹, and F. D. Alvarez-Valenzuela¹, ¹*Instituto de Ciencias Agricolas, Universidad Autonoma de Baja California, Mexico*.

Two trials were conducted with seventy-six Holstein calves to compare daily weight gains and economics of three different liquid feeding systems. All calves received 2 l of colostrum at 6 and 12 h after birth and 4 l of whole milk until day 30 in trial 1 (n=34 and average birth weight of 33.7 kg) and until day 20 in trial 2 (n=35 and average birth weight of 27.2 kg). Calf starter and alfalfa hay were offered from the first week of age until day 60. Calves were alternately assigned to one of three treatments: 1) whole milk (4 l of milk), 2) commercial milk replacer (400 g of milk replacer in 3.6 l of water), and 3) combination of the previous treatments (2 l of milk replacer and 2 l of whole milk). Calves were maintained in pens during the trial. Information was analyzed using a statistical model that included sex, treatment, and the effects sire and initial weight as covariables. In trial 1, average daily weight gain and final weight were similar (P>. 05) for treatments 1, 2, and 3 (0.71 \bar{n} 0.45, 0.70 \bar{n} 0.44, and 0.72 \bar{n} 0.45 kg, and 65.6 \bar{n} 1.35, 65.5 \bar{n} 1.33, and 66.1 \bar{n} 1.37 kg) respectively. The cost of feeding during the 30 d of the trial was 440, 239 and 321 dollars for treatments 1, 2, and 3 respectively. In trial 2, average daily weight gain and final weight were similar (P>. 05) for treatments 1, 2, and 3 (0.71, 0.64, and 0.68 kg with a S.D. of 0.04, and 63.0 \bar{n} 1.63, 60.0 \bar{n} 1.72, and 61.8 \bar{n} 1.79 kg) respectively. The cost of feeding during the 40 d of the trial was 640, 366, 452 dollars for treatments 1, 2, and 3 respectively. The use of milk replacer represents an economical alternative that can be used for dairy producers in the Mexicali valley, Baja California, Mexico.

Key Words: dairy calves, milk replacer, economics

649 Recovery of degraded tropical pastures using the Barreirao system. I. P. Oliveira¹, J. Kluthcouski¹, C. U. Magnabosco*², L. C. Balbino¹, R. S. M. Santos¹, L. P. Yokoyama¹, and R. D. Sainz³, ¹*Embrapa Arroz e Feijao*, ²*Embrapa Cerrados*, ³*University of California, Davis*.

Millions of hectares of pasture in Brazil present serious problems of chemical, biological and physical degradation. We studied direct and indirect systems of pasture recovery to reverse this process. Cost recovery in the direct systems is delayed because of the lag in producing

animals for market. The indirect system (Sistema Barreirao) involves a sequence of soil preparation operations, and planting of new pastures in association with an annual crop. A cooperating farm was selected in the district of Parana - Goiás state, with predominantly medium texture, low fertility Oxisol. The traditional system is characterized by meat and milk production on pasture, with a small area destined to grain crops. The pastures planted in the 1970's presented low carrying capacities, and forage and concentrate production was insufficient for animal maintenance. Three alternative systems were compared during eight months: A) Traditional; B) Barreirao system, using upland rice and *B. brizantha*; and C) Barreirao system, using corn and *B. brizantha*. Systems B and C produced 2,821 and 3,040 kg/ha of paddy rice and corn, respectively. Subsequent green forage masses were 2.82 and 6.65, 8.91 and 19.61, and 7.87 and 20.27 kg/ha for A, B and C during the dry and rainy seasons, respectively. The overall stocking rates were 0.94, 2.19 and 2.00 AU/ha for A, B and C, being 0.52 and 1.35, 1.67 and 2.70, and 1.44 and 2.57 for A, B and C during the dry and rainy seasons, respectively. The total weight gains by cattle were 117, 732 and 639 kg/ha for systems A, B and C, respectively. These were divided into 42 and 75, 199 and 533, and 133 and 506 kg/ha for A, B, and C during the dry and rainy seasons, respectively. We conclude that systems B and C were successful in recovery of pastures, but that system B yielded higher returns in both grain production and animal gains. This system enables more rapid cost recovery, through production of a cash crop.

Key Words: Pasture, Crops, Recovery

650 **Hydropic-fetal membranes in cows from an endemic region in Southern Zacatecas State, Mexico.** F Flores¹, J Valencia², R Rosiles², R Banuelos-Valenzuela^{*1}, and CF Arechiga¹, ¹FMVZ-Universidad Autonoma de Zacatecas, ²FMVZ-Universidad Nacional Autonoma de Mexico.

Quantity and volume of amniotic and allantoic fluids in healthy Zebu/crossed cows was determined throughout the nine months of gestation (n=90). Metabolites in amniotic and allantoic fluids were measured at each third of gestation. Moreover, necropsies were practiced in healthy (n=10) and hydropic cows (n=5) from an endemic region in southern Zacatecas State in Mexico. Anatomy, pathology and blood exams were performed, as well as evaluation of metabolites in amniotic and allantoic fluid, in order to determine differences among healthy and hydropic cows. Results showed that quantity of amniotic and allantoic fluids increase as fetal size increases. At 1st third of gestation, healthy cows showed greater levels of Cl, Na, K, Mg, P, Ca and creatinin (P<0.05) in amniotic fluid than allantoic fluid, but uric acid was lower (P<0.01). At 2nd third of gestation, Cl, Na and glucose increased (P<0.05) in amniotic fluid, and Mg, K, uric acid and creatinin increase in allantoic fluid (P<0.01). By the end of gestation, Cl, K and uric acid increased, but Na decrease in amniotic fluid (P<0.01). In conclusion, healthy cows showed increased levels of Cl, Na, glucose, uric acid, and total protein in amniotic fluid. As well as greater levels of K, Mg, glucose, creatinine and uric acid; but lower Cl, Na and total protein in allantoic fluid than in hydropic cows. Blood levels of Cl, Mg, glucose, cholesterol and glutamic-oxaloacetic transaminase were greater in hydropic cows than healthy cows (P<0.01) with no differences among Ca, P, K, Na, uric acid and total protein. Hydropic cows had amniotic and allantoic fluids in a range of 80-110 L, smaller placentomes and adrenal glands, degenerated pituitary and thicker placenta with edema (even 10 cm of thickness).

Key Words: cow, hydrops, fetal membranes

651 **Effect of male presence on reproductive function and estrous cycle succession in Mexican-Criollo goats exposed to a controlled photoperiod.** R. M. Rincon^{*1}, F. de la Colina¹, F. J. Escobar¹, R. Banuelos-Valenzuela¹, J. Valencia², and C. F. Arechiga¹, ¹FMVZ-Universidad Autonoma de Zacatecas, ²FMVZ-Universidad Nacional Autonoma de Mexico.

The purpose of the present study was to determine whether it was possible to increase reproductive activity (i.e., shorten anestrus season) by controlling buck presence, in mexican-criollo goats under a defined photoperiod. Thus, reproductive function of mexican-criollo goats (n=10) exposed to a six-months long photoperiodic cycles was evaluated either, in the presence or not of a male buck. Goats were housed in controlled chambers and artificially exposed to light in a range of 10.6 to 13.4 hours

per day increasing and decreasing gradually throughout a six-months cycle (instead of a whole year as normally occurs at our research station in Zacatecas, Mexico; latitude 22, 57' N). Goats were randomly assigned to two groups of five animals each: 1) goats exposed to a sexually active male wearing a harness that prevented coitus, and, 2) goats not exposed to male. Blood samples were collected twice weekly and progesterone was determined by radioimmunoassay. The presence of the male shortened anestrus and increase reproductive function and estrous cycle succession. In Group 1, male presence increased ovarian activity during longer light-hours days, while, in Group 2, goats still remained in anestrus. Mean number of estrous cycles during long days were 3.2 \bar{n} 0.8 vs. 0.8 \bar{n} 0.8 for Groups 1 and 2, respectively (P<0.05), and did not differ during shorter light-hours days (5.6 \bar{n} 1.1 vs. 6.0 \bar{n} 0.7, for Groups 1 and 2, respectively) (P>0.05). In conclusion, the presence of a male increased reproductive function of female goats exposed to a six-months long photoperiodic cycles shortening the anestrus period and improving estrous cycle succession.

Key Words: goat, photoperiod, male effect

652 **Serum calcium and phosphorus levels throughout the year in six beef cow genotypes grazing semi-arid range at the northeast of Mexico.** E.M. Romero-Treviño*, M. Castillo-Martinez, E. Gutiérrez-Ornelas, E. Olivares-Saenz, H. Bernal-Barragan, and C. De-Luna-Villarreal, *Universidad Autonoma de Nuevo Leon, Mexico.*

One hundred forty cows and 17 heifers representing Charolais, Simmental, Beefmaster, Brangus, Hereford and Bradford breeds from six production units in the Northeast of Mexico were sampled throughout a year to evaluate the effect of season of the year on body condition score (BCS) and their levels of Ca and P in blood serum. Native and introduced grasses such as *Bouteloua gracilis* and *Cenchrus ciliaris* were the principal forage species available for grazing. Mineral supplementation practices varied from minimal to adequate. Blood samples were taken from the coccigea vein, they were centrifuged at 970 X g for 10 min to separate serum which was kept frozen (-20° C) until the analysis. Serum was analyzed for Ca and P using the atomic absorption and colorimetric procedures, respectively. Effects of genotype and season were analyzed using the GLM procedure, using production units as the blocking criteria. There was difference (P > .05) in the changes in BCS recorded among the breeds throughout the year. Serum Ca levels ranged (P < .05) from 6.8, during spring, to 10.9 mg/dL during winter and cows from only one production unit were marginal deficient for Ca. Charolais and Beefmaster cows trend to have lower Ca levels than the rest of the genotypes, but no effect (P > .05) was found for P levels. Serum P levels ranged (P < .05) from 4.0, during spring, to 8.5 mg/dL during summer in heifers. Supplementation strategies should be developed to provide adequate supply of Ca and P.

Production unit	1	2	3	4	5	6
Ca:P (mg/dL)						
Spring	8.5:4.0	6.8:5.4	8.6:5.4	10.0:5.2	8.6:6.0	10.3:6.5
Summer	8.8:6.0	8.7:5.0	9.2:6.0	10.2:4.7	9.2:6.9	
Autumn	9.7:4.9	8.7:6.9	10.1:6.8	9.9:8.6	10.8:5.7	8.9:6.4
Winter	8.9:5.8	7.9:6.8	10.2:6.0	10.9:4.6	8.7:7.1	11.3:4.3
SE±	.10:.19	.12:.20	.12:.16	.11:.14	.13:.16	.14:.17

Key Words: Calcium, Phosphorus, Beef cows

653 **The effect of molasses-urea supplementation on high fiber buffalo diets in Gujarat State, India on production parameters and methane losses.** G.W. Turnbull*, B. Ducharme, R. Livingston, and R. Bowman, *Global Livestock Group.*

The objective was to evaluate the effect of molasses-urea supplementation on typical high fiber diets in Gujarat State, India on milk production, butterfat production, weight gains, reproductive performance and methane production. Sixteen buffalo blocked by weight and lactation number were randomly assigned to either a basal ration (BR) or BR plus a molasses-urea supplement (BR-MU). The BR consisted of mixtures of rice straw, wheat straw, Jowar, alfalfa, cottonseed cake and wheat bran. Daily feed offerings, orts, milk production and reproductive performance were recorded. Milk samples taken from two consecutive milkings were used for butterfat analysis. Body weights were taken every 14 days. Four animals from each group were randomly chosen to measure daily

methane emissions. Methane was measured using an internal tracer (sulfur hexafluoride, SF₆) method. The buffalo were fitted with collection canisters and measurements were taken for five consecutive days. The gases were analyzed using a gas-liquid chromatograph equipped with a flame-ionization detector and an electron capture device. Results were analyzed using analysis of variance procedures. Buffalo consuming the BR-MU produced more 4% Fat Corrected Milk as compared to the BR group ($P < 0.05$) (63.7 liters vs. 51.8 liters). When analyzed monthly, buffalo consuming the BR-MU produced more milk per month ($P < 0.05$) as compared to buffalo consuming BR. Likewise, buffalo consuming the BR-MU has a greater butterfat concentration as compared to the BR group ($P < 0.05$) (6.6% vs. 6.0%). Furthermore, the average weight gain of buffalo consuming the BR-MU was greater ($P < 0.05$) than the BR group (28 kg vs. 15 kg). Daily methane production for the buffalo consuming the BR-MU was 190 grams per day as compared to 239 grams per day for the BR group ($P < 0.05$). Supplementing typical high-fiber buffalo diets with a combination of molasses-urea resulted in greater daily production of butterfat, milk and weight gain. Furthermore, the addition of molasses-urea resulted in a 20% reduction in the amount of methane produced per animal and the amount of methane per unit of 4% FCM was 34% less. The data suggests that the supplementation of high fiber diets with a molasses-urea combination will reduce methane emissions.

Key Words: methane production, global warming, molasses-urea supplementation

654 SUPEROVULATORY response and embryo recovery in buffalo heifers and cows treated with Super-Ov and LH gonadotropins. A.M. Osman*, S.H. Shehata, and G.A. Megahid, *Dept Theriogenology, Fac. Vet. Medicine, Assiut University, Assiut.*

Superovulation and nonsurgical embryo collection were tried on 5 heifers and 10 buffalo cows. These animals were healthy, cycling, non lactating

MEAT SCIENCE AND MUSCLE BIOLOGY

655 Pork quality of pigs finished indoors or outdoors under a commercial setting. J.G. Gentry, J.R. Blanton, J.J. McGlone, and M.F. Miller*, *Texas Tech University, Lubbock.*

The objective of this study was to determine the effects of outdoor and indoor housing on pork quality of pigs. Barrows and gilts were randomly selected from a group of indoor raised pigs and placed into one of two housing systems. The outdoor housed pigs were finished on a dirt lot while the indoor housed pigs were finished on concrete slats. The average initial weight of the pigs was 30 kg. Carcass data were collected and boneless loins were aged for 14 days. Pork loins were cut into 2.54 cm thick chops and frozen for further analysis. Retail shelf life was evaluated on chops aged 14 days in a simulated retail case. Chops were scored daily for color, uniformity, discoloration and browning. Hunter L*, a*, b* measurements were taken at the 10th rib. Other measurements included subjective color, firmness, and marbling, Warner-Bratzler shear force (WBS) and sensory panel scores for tenderness, juiciness and flavor. No differences were detected for average daily gain ($P > .05$). Outdoor finished pigs had a larger loin eye area ($P = .0003$), whereas indoor finished pigs had a higher NPPC marbling score ($P = .001$). There were no significant differences in 6, 12 or 24 hr pH measurements of the *Longissimus dorsi* muscle. No differences were detected for sensory evaluation except, indoor pigs had a higher initial juiciness score ($P = .003$), which may be attributed to the higher marbling score. Retail display scores were similar among the groups, but the outdoor finished pigs had lower visual color scores on day 1 and day 4 ($P < .05$). These results indicate little differences in pork quality of pigs finished in outdoor and indoor environments.

Key Words: Pigs, meat quality, environment

656 The effect of magnesium supplementation on pork quality. R. vanLaack*¹, ¹*Department of Food Science and Technology, University of Tennessee, Knoxville.*

The objective of the study was to determine the feasibility of improving pork quality by magnesium supplementation, as magnesium-sulfate. In a pilot study, we determined that the level and duration of magnesium

and 2-5 years old. They were selected from those raised in a local buffalo farm. Through rectal examinations, these animals were assigned to be at mid luteal phase before superovulation treatment. Super-Ov (purified porcine FSH: Mfd. in Canada by W.A. Montreal Inc.) was administered intramuscular, morning and evening for 3 consecutive days (Total 75 NIH. unit divided into 6 equal doses). Lutalyse 25 mg was injected with the fifth Super-Ov injection according to manufactures instructions. In addition, 2000 USP unit chorionic gonadotropine (Steris, Lab. Inc. Phoenix, Arizona) was injected at the 5th day of the treatment to improve rate of ovulation. All buffaloes were closely observed by experts to detect the onset and duration of oestrus. Buffalo bulls were allowed to mount female at oestrus several times. Rectal examinations was performed to count numbers of corpora lutea (CL) and unovulated follicles at day 7 from breeding and just before the nonsurgical embryo collection. The onset of oestrus began earlier in heifers than cows (16.0 + 1.4 and 24.7 + 9.9 hours respectively) and the difference was significant ($P < 0.05$). The duration of oestrus was significantly shorter ($P < 0.05$) in cows than heifers (30.2 + 3.7 and 39.2 + 8.1 hours respectively). The number of CL was significantly higher ($P < 0.01$) in cows than heifers (4.2 + 1.03 and 2.4 + 0.5 respectively). The number of unovulated follicles was significantly higher ($P < 0.05$) in heifers than cow (4.4 + 1.6 and 2.3 + 0.67 respectively). The ovulation rate is higher in cows (83%) than heifers (35%). Uterine flushing failed in 3 cases due to narrow cervix (2 heifers) and subclinical endometritis (1 cow). The other flushing revealed a total of 12 embryos with a recovery rate of 27.9% (range from 0-66%) from the cows only. The used protocol appeared satisfactory in buffalo cows rather than heifers.

Key Words: Superovulation, Buffalo, Embryo

supplementation required to increase blood levels of magnesium (Mg) by 10% was 2 g elemental Mg/kg feed for 5 days before slaughter. The final concentration of Mg in the control and supplemented feed were 1.3 and 3.7 g Mg/kg feed, respectively. Subsequently, 100 halothane-negative pigs were supplemented at this level of magnesium for 5 days before slaughter. One-hundred non-supplemented pigs of the same genetic line were used as control group. Pigs were slaughtered on day 6, after 12 h fasting and transport to the packing plant. Blood, collected immediately after slaughter, was analyzed to determine Mg concentration. Blood Mg concentration in supplemented animals was 10% higher than in the control group ($P < 0.05$). At 30 min, and at 3, 5 and 20 h postmortem, the pH in the loin was 6.43, 6.39, 6.20 and 5.71 respectively. Mg supplementation did not influence the pH decline. Meat quality characteristics at 24 h postmortem (color and water holding capacity) of the loin and ham (semimembranosus muscle) were not influenced by Mg supplementation. Mg supplementation did not influence purge % and shear force of 3 weeks stored loins. We conclude that in normal halothane-negative pigs, short term Mg supplementation does not significantly improve pork quality or reduce purge losses.

Key Words: Magnesium supplementation, Water-holding capacity, Color

657 Effect of chromium-methionine supplementation on the apparent muscle fiber number in newly hatched Japanese quail (*Coturnix coturnix japonica*) under heat stress condition. G. Contreras*, F. Rios, and R. Barajas, *Universidad Autonoma de Sinaloa, Sinaloa, Mexico.*

The fact that chromium stabilize nucleic acids is known, in concordance with that, the hypothesis that organic chromium supplementation increase myofiber number was tested in this study. Our objective was to determine the effect of chromium-methionine supplementation on apparent muscle fiber number in newly hatched Japanese quail under heat stress condition. A complete randomized design experiment was conducted. 320 breeders Japanese quail (240 females and 80 males) were divided in 10 groups of 32 avian (24 females and 8 males), and allocated in metal wire cages. The quails were randomly assigned to one of two experimental diets: 1) Diet containing 21% CP and 2.9 Mcal of

ME/kg (control); and 2) Diet similar to control, but supplemented with 200 ppb of Cr from chromium-methionine. Twenty-four (12 by treatment) newly hatched quail (1 day old) were randomly selected to be slaughtered. The iliobtibialis cranialis muscle was dissected and stained. From each of 24 muscle-samples one microphotography (400 X) was taken, and the apparent muscle fiber number was counted in paper photo. The mean and maximum mean temperature were 29C and 34.7C respectively. Chromium-methionine supplementation diminished ($P < 0.01$) daily feed intake by 9.7% (5.4 vs 4.9 g/d). The percentage of eggs hatching (77.25 vs 78.92%), and hatchability (51% vs 50%) were not affected ($P > 0.10$) by treatments. The chromium-methionine supplementation reduced ($P < 0.05$) apparent muscle fiber number by 22.5% (6,428 vs 4,964 cells/mm²) in the iliobtibialis cranialis muscle. It is concluded, that chromium-methionine supplementation under heat stress condition reduced feed intake and apparent muscle fiber number of Japanese quail.

Key Words: Chromium, Japanes quail, Heat stress

658 Enhancement of conjugated linoleic acids in beef steers fed different levels of full-fat extruded soybeans. M. Madron*¹, D. Peterson¹, D. Dwyer¹, D. Beermann², and D. Bauman¹, ¹Cornell University, Ithaca, NY, ²University of Nebraska, Lincoln.

Conjugated linoleic acids (CLA) have been shown to have anti-cancer properties and other beneficial health effects in biomedical studies with animal models. Rumen biohydrogenation of polyunsaturated fatty acids is involved in CLA production and dietary supplement with extruded full-fat soybeans results in a marked increase in milk fat content of CLA in dairy cows. Crossbred Angus steers (n=30) were used to determine if the conjugated linoleic acid content of adipose tissue could be increased by feeding varying levels of extruded full-fat soybeans during the finishing phase of growth. Diets were 1) control 2) 12.5% extruded full-fat soybeans (LESB) and 3) 25% extruded full-fat soybeans (HESB). Steers were individually housed and total days on feed was 111. The starting weight averaged 417 kg and the average daily gains were 1.64 kg for control, 1.68 kg for LESB and 1.72 kg for HESB. The average final slaughter weights for the groups was 592 kg for control, 599 kg for LESB, and 618 kg for HESB. Time of slaughter was determined by visual evaluation of finish and average dressing percentage across the entire group was 62%. All steers were A maturity and quality grades ranged from prime- to choice-. At slaughter the chuck, round, and loin were removed and processed for analysis. From each meat cut three adipose tissue depots (subcutaneous, intermuscular, and intramuscular) were sampled for CLA analysis. The CLA content was measured using gas chromatography and to date analysis for 5 steers per diet has been completed for the loin muscle. All three adipose sites for the loin muscle had similar CLA content so values were averaged. The CLA content in adipose tissue from the loin muscle did not differ among treatments and averaged 4.8, 4.7 and 5.5 mg/g of fatty acids for the control, LESB and HESB diets respectively. Thus, altering the supply of fatty acids for rumen biohydrogenation by use of extruded full-fat soybeans had no effect on CLA content in the fat from the loin muscle.

Key Words: CLA, Extruded, Beef

659 Effect of pre-harvest oral calcium gel administration on tenderness. S. K. Duckett*¹, J. G. Andrae¹, G. T. Pritchard¹, S. L. Cuvala¹, and J. Church¹, ¹University of Idaho, Moscow.

Twenty-four Charolais-cross spayed heifers and steers (540 kg) were used to determine the effect of administering an oral calcium gel at 3 to 4 h before harvest on tenderness in three muscles. Animals were randomly assigned within sex to one of the following treatments: controls, 1.5 L of water dosed orally (N) and calcium gel, 1.5 L of Dr. Larson's Up and Over 1000, (150 g of calcium) dosed orally (CA). Serum calcium levels were measured before dosing and at harvest. Longissimus pH and temperature levels were monitored at 1, 3, 6, 12, and 24 h postmortem. Samples were taken at 1 h postmortem for determination of calpain/calpastatin activity. At 24 h postmortem, carcass data were collected and four steaks (2.54 cm thick; aged 1, 3, 7, and 14 d) were removed from longissimus (LM), supraspinatus (SS) and semitendinosus (ST) for Warner-Bratzler shear force (WBS) determination. Data were analyzed with sex, treatment, time (if appropriate) and all interactions tested. For serum and muscle traits, sex and sex by treatment interaction were not significant ($P > .05$). Serum normalized calcium levels

were similar ($P > .05$) between treatments before dosing and 32% higher ($P < .05$) for CA than N at harvest. Longissimus pH levels declined ($P < .05$) over time but were lower ($P < .05$) for CA than N. Free calcium levels in the longissimus were elevated ($P < .05$) by 41% and 84% for CA than N at 1 and 24 h, respectively. Activity of u- and m-calpain per g of muscle was 12% and 20% higher ($P < .05$) for CA than N. Total calcium content of LM was 32% higher ($P < .05$) for CA than N; however, total calcium values were similar ($P > .05$) between treatments for SS and ST. WBS values and variation were lower ($P < .05$) for CA than N in LM. In the SS and ST, WBS values were similar ($P > .05$) between treatments; however WBS variation within the muscle was lower ($P < .05$) for CA than N. Pre-harvest calcium gel administration elevated serum and longissimus calcium levels and activated the calpains to improve tenderness. However, other muscles (ST and SS) were less responsive.

Key Words: Beef, Calcium, Tenderness

660 Impact of high oil corn on beef steak quality. S.K. Duckett¹, B.A. Gardner*², M.A. Hinds³, and F.N. Owens³, ¹University of Georgia, Athens, ²Oklahoma State University, Stillwater, ³Optimum Quality Grains, L.L.C., Des Moines, IA.

Ribeye (longissimus) steaks were obtained from 200 steers fed either high oil or typical corn grain for Warner-Bratzler shear force measurements and evaluation by 8-member trained taste panels. Steaks were gathered at commercial packing plants from steers fed in trials at a commercial feedyard in western Kansas (92 steaks), the University of Idaho (28 steaks), and the Pioneer Livestock Nutrition Center in Johnston, IA (80 steaks). Of these steers, 66% of those fed high oil corn and 64% of those fed typical corn graded U.S. Choice or greater. Mean carcass weight, yield grade, marbling score, skeletal maturity, and fat thickness (355 kg, 3.25, 534, 117, and 1.1 cm.) were not significantly altered by corn source. Compared with steaks from steers fed typical corn, steaks from steers fed high oil corn had greater juiciness (4.97 vs 4.71; $P < .02$) and tenderness (5.42 vs 5.20; $P < .02$) when tested using the trial by corn type interaction. When marbling score was included as a covariate, shear force tended to be lower for those steers fed high oil corn (3.66 vs 3.77 kg; $P < .06$). Steers that graded U.S. Choice tended to have lower ADG (1.57 vs 1.69 kg; $P < .06$) but higher yield grades (3.28 vs 3.05; $P < .01$) than steers that failed to grade U.S. Choice. Steaks from carcasses that graded U.S. Choice were juicier (4.97 vs 4.69; $P < .01$) and tended to be more tender (5.49 vs 5.08; $P < .15$) and flavorful (5.18 vs 5.06; $P < .07$) and have lower shear force (3.64 vs 3.81; $P < .21$) than steaks from steers graded below U.S. Choice. Interactions between quality grade and corn source suggested that high oil corn had adverse effects on steak flavor of steaks not grading U.S. Choice but improved juiciness most for steaks from carcasses that graded U.S. Choice or above. Correlations between marbling score and shear force, steak juiciness, tenderness, and flavor were low ($r = -.19; .18; .28$; and $.09$).

Key Words: High Oil Corn, Meat Quality, Tenderness

661 Impact of high oil corn on meat quality. B.J. Johnson*¹, D.M. Wulf¹, M.S. Eibs¹, B.J. Reuter¹, J.M. Bok¹, B.D. Rops¹, and F.N. Owens², ¹South Dakota State University, Brookings, ²Optimum Quality Grains, Des Moines, IA.

Angus-sired steer calves (N = 153) were fed on a high concentrate diet consisting of either typical corn (C:79.5% of ration), high oil corn (HOC: 79.5% of ration), or high oil corn fed at level isocaloric to typical corn (ISO; 74.5% of ration) for 156 days. Rib sections were removed 72-h postmortem. Steaks (2.54 cm thick) were cut from rib sections and used for retail display panel (RDP), Warner-Bratzler shear force (WBS), and trained sensory panel (TSP) measurements. Samples of grain and meat were collected for tocopherol analysis. Three storage treatments were used prior to RDP: 1) domestic chilled (DC), chilled storage for 13 d postmortem; 2) export chilled (EC), chilled storage for 34 d postmortem; 3) export frozen (EF), chilled 3 d postmortem then frozen 56 d. Samples for TSP and WBS were aged for 14-d postmortem. RDP was monitored for 9 d (d 0-8) under simulated retail meat display conditions with samples appraised visually by a 5-member panel. On d 8, thiobarbituric reactive substances (TBARS) of RDP samples were quantified. Preplanned contrasts were used to assess treatment differences. HOC contained greater ($P < .05$) alpha and gamma-tocopherol levels than C (3.72 and 11.43 vs 1.95 and 5.38 mg/kg). Ribeye samples from steers fed HOC also contained greater ($P < .05$) levels of both alpha-tocopherol

(2.49 vs 1.66 ppm) and gamma-tocopherol (.34 vs .18 ppm) than samples from steers fed C. Rate of discoloration, as appraised by RDP, was slower ($P < .05$) in steaks from steers fed HOC than steers fed C for EC storage treatment, with case life extended by approximately 2 d. TBARS were lower ($P < .05$) in samples from steers fed HOC and ISO than steers fed C for the EC steaks (.548, .455 vs 1.059 mg of malonaldehyde/kg tissue). No treatment differences ($P > .10$) were detected for TSP or WBS measurements. These data suggest that substituting high oil for typical corn in diets for finishing beef steers will elevate tocopherol levels in beef and extend case life of beef for export.

Key Words: High oil corn, Beef, Case life

662 Effect of dietary lycopene supplementation for eight weeks before slaughter on lycopene accumulation in tissue, fat color, and meat quality during display in Japanese Black steers. M. Mitsumoto*¹, K. Sasaki¹, T. Ito², K. Hodate¹, H. Abe¹, Y. Kawakita¹, S. Oshima³, and T. Inakuma³, ¹National Institute of Animal Industry, Tsukuba, Japan, ²Nagano Animal Industry Experiment Station, Shiojiri, Japan, ³Kagome Research Institute, Nishinasuno, Japan.

Effects of dietary lycopene supplementation to steers for eight weeks on lycopene accumulation in tissue and fat color, and meat quality during display were studied. Three Japanese Black steers were fed no supplemental lycopene and three were supplemented with 3,000 mg of lycopene mixed in 8 kg concentrate per animal daily for eight weeks before slaughter. Blood samples were drawn before and after dietary lycopene supplementation. Samples of liver, subcutaneous and intermuscular adipose tissue, semitendinosus (ST) and longissimus thoracis (LT) muscles were obtained after slaughter. Fat color (L^* , a^* and b^* values) was measured before freezing. These tissues were vacuum-packaged and stored at -20°C until required. The lycopene concentrations of plasma and tissue samples were determined by the HPLC method. Steak samples from thawed ST and LT muscles were over-wrapped with PVC film and displayed under fluorescent lights at 4°C for 10 days. Drip loss percentages, meat color, metmyoglobin percentages, and 2-thiobarbituric acid reactive substances values were determined at day 1, 4, 7 and 10. Dietary lycopene supplementation accumulated ($P < .01$) lycopene in the plasma, liver and subcutaneous adipose tissue, but did not in the intermuscular adipose tissue and muscles. Dietary lycopene increased ($P < .01$) a^* and b^* values of fat color compared to the control. Dietary lycopene did not improve ($P > .05$) drip, meat color and lipid stability during display compared to the control. The data indicated that dietary lycopene was absorbed in small intestine and incorporated into plasma lipoproteins, and transferred to liver and subcutaneous adipose tissue, but not to muscles. Therefore, dietary lycopene could not work for retaining meat quality during display.

Key Words: Lycopene, Fat color, Meat quality

663 Carcass, sensory, and adipose tissue traits of Brangus steers fed casein-formaldehyde-protected starch and(or) canola lipid. C. D. Gilbert*, D. K. Lunt, R. K. Miller, and S. B. Smith, Texas A&M University, College Station.

Eighteen Brangus steers of similar live weight were assigned randomly to one of three dietary treatment groups: cracked corn (Corn), casein-formaldehyde-protected Canola Lipid (CL), or casein-formaldehyde-protected Marble Plus (MP). The purpose of the study was to determine if feeding protected starch and lipid increased marbling scores without increasing carcass fat. All diets were equally balanced for ME (291 Mcal/kg), crude protein (12.5%), and dry matter (89%). Ether extract was 3.7, 6.9, and 6.9% for the Corn, CL, and MP diets, respectively. The CL and MP diets provided equal amounts of protected lipid (3.3%). The MP also contained 3.7% protected starch. Steers were fed their respective diets for 126 to 130 d before slaughter. Beef carcasses from steers fed Corn, CL, or MP did not differ in adjusted fat, ribeye area, hot carcass weight, or yield grade ($P \geq 0.23$). Percentage KPH fat was higher ($P < 0.05$) for CL and MP carcasses than for Corn carcasses. Marbling score and quality grade did not differ among treatment groups; nor did Warner-Bratzler shear force, meat palatability, or sensory flavor attributes of steaks ($P \geq 0.13$). Subcutaneous and i.m. adipose tissue explants were incubated with 5 mM [$U-^{14}\text{C}$]glucose \pm 0.1 mU/mL insulin. Glucose incorporation into total lipids (TL), glyceride-glycerol (GG), and fatty acid (FA) fractions were highest ($P < 0.05$) in s.c. adipose tissue from steers fed MP, but was unaffected by diet in i.m.

adipose tissue. Insulin did not affect ($P > 0.05$) glucose incorporation into TL, GG, or FA for s.c. adipose tissue, but tended ($P < 0.06$) to increase incorporation into TL in i.m. adipose tissue. Percentages of 16:1 and 17:1 were lower ($P < 0.05$), and 18:2 and 18:3 were higher ($P < 0.05$), in CL and MP tissues. This indicates that the protected diets decreased ruminal biohydrogenation of fatty acids. These data indicate that the increased availability of glucose and unsaturated fatty acids to the small intestine modified s.c., but not i.m., adipocyte metabolism.

Key Words: Steers, Adipose Tissue, Protected Fat

664 Fatty acid composition of muscle from beef cattle fed pre-slaughter rations based on grass silage or maize silage. A.P. Moloney*¹, P. French¹, P. O'Kiely¹, and C. Stanton², ¹Teagasc, Grange Research Centre, Dunsany, Co. Meath, Ireland, ²Teagasc, Dairy Products Research Centre, Moorepark, Co. Cork, Ireland.

Human health benefits are associated with increased polyunsaturated (PU) : saturated (S) fatty acid (FA) ratio, decreased n-6 to n-3 PUFA ratio and increased concentration of conjugated linoleic acid (CLA) in the diet. The objective of this study was to determine the concentration and ratios of FA in muscle from heifers fed combinations of grass silage and maize silage prior to slaughter. Forty-five crossbred heifers were offered *ad libitum*, grass silage, a mixture of 500 g grass silage and 500 g maize silage/kg dry matter or maize silage in a randomised block design. Animals received 3 kg concentrates daily and were slaughtered after 167 days when samples of the *m. longissimus dorsi* were collected. The FA profile (g/kg FA) of grass silage and maize silage, respectively, was oleic acid 44 and 158, linoleic acid 198 and 563 and linolenic acid 473 and 55. For grass silage, mixed silages and maize silage, respectively, the concentration of lipid in *longissimus* muscle averaged 38, 45 and 49 (s.e.d. 0.7) g/kg, SFA averaged 443, 449 and 455 (s.e.d. 9.0) g/kg FA, monounsaturated FA averaged 452, 452 and 461 (s.e.d. 9.3) g/kg FA, PUFA averaged 47, 47 and 44 (s.e.d. 5.6) g/kg FA and CLA averaged 3.5, 3.6 and 3.6 (s.e.d. 0.37) g/kg FA, none of which was affected by diet. Increasing maize silage in the ration linearly decreased ($P < 0.05$) the proportion of linolenic acid (7.3, 6.1 and 4.5 g/kg FA) and unidentified unsaturated FA (59.5, 54.5 and 40.4 g/kg FA) and linearly increased ($P < 0.05$) the n-6 : n-3 PUFA ratio (5.1, 6.7 and 8.5). It is concluded that the source of conserved forage in the ration influences the FA profile of beef and that grass silage inclusion results in a more beneficial FA profile from a consumer health perspective than maize silage.

Key Words: Fatty Acids, Conjugated Linoleic Acid, Beef

665 Carcass and meat quality of calf-fed, short- and long-yearling steers. R. D. Sainz, M.C. Coelho, and R.F. Ver-nazza*, University of California, Davis.

Sixty Angus-hereford steers were allocated at weaning (May 1997) to three groups. Calf-fed (CF) steers were sent to the UCD feedlot immediately, short-yearlings (SY) remained on irrigated pasture until Sept. 1997, then sent to the feedlot, and long yearlings (LY) remained on irrigated pasture until Sept. 1997, then on native range until May 1998, then sent to the feedlot. All steers were fed on a high-energy corn-based ration until average ultrasound backfat for the group reached 12.7 mm. Backfat had significant effects on most carcass variables studied, except for ribeye area. At equal slaughter weight, CF had more backfat (12.2 mm) than both SY and LY (9.9 and 9.7 mm, respectively; $P < 0.05$). At equal backfat depths (mean 10.6 mm), LY steers had heavier live and carcass weights (526 and 318 kg) than CF (448 and 285 kg) and SY (452 and 280 kg) steers, respectively. CF steers had the most ($P < 0.05$) KPH (2.24%), SY had the least (1.86%), and LY were intermediate (2.21%). CF steers had higher ($P < 0.05$) fat contents in the longissimus muscle (3.05%) than both SY (2.25%) and LY (2.61%). Carcass fat content tended ($P < 0.10$) to follow the same pattern (28.1, 26.8 and 25.3% for CF, SY and LY, respectively). Ribeye area ($71.2 \pm 6.6 \text{ cm}^2$) and marbling score (9.12 ± 1.95 , where 9 is Slight+ and 10 is Small-) were not affected by nutritional background. There were no differences ($P > 0.05$) among groups in Warner-Bratzler shear force ($3.44 \pm 0.70 \text{ kg}$), or panel tenderness, juiciness, flavor intensity or flavor quality (5.12 ± 1.01 , 4.62 ± 0.98 , 4.93 ± 0.55 , and 5.32 ± 0.48 , respectively, on a 1 to 8 scale). These results confirm that backgrounding increases the weight at which cattle reach slaughter finish. Moreover, neither objective nor subjective measures of meat quality were affected by varying feeding periods from

83 to 192 days. Prolonged grazing can be used to reduce the length of feeding without adverse effects on carcass or meat quality.

Key Words: Carcass, Meat quality, Beef cattle

666 Effects of pre-feedlot growth rate on carcass composition and meat tenderness. I.T. Brigan^{*1}, R.K. Miller¹, G.E. Carstens¹, and F.M. Rouquette^{2, 1} *Texas A&M University, College Station, 2 Texas A&M University, Overton.*

To examine pasture growth rate effects on carcass composition and tenderness, weaned calves (106 steers; 43 heifers) of two breed types (Angus x Brahman; Simmental-sired calves from F1 Bos indicus x Bos taurus dams) were grazed on ryegrass pasture at one of three stocking rates (SR). Calves were randomly assigned within breed type and sex to low (1.5 hd/Ac), medium (2.1 hd/Ac) or high (2.75 hd/Ac) SR pastures. After grazing for 130 d, calves were fed a high-grain diet in a commercial feedlot. To target a similar carcass-weight slaughter endpoint, low- and medium-SR calves were slaughtered after 131 d on feed, whereas, high SR calves were slaughtered after 175 d. Carcass characteristics were measured 36 h postmortem. Soft tissue from 9-10-11 rib sections was analyzed for fat, protein and moisture content. Longissimus muscle sections were aged for 35 d and 2.54 cm steaks removed to measure Warner-Bratzler (WB) shear force. Grazing ADG was affected by SR (1.15, .76 & .36±.04 kg/d for low, medium & high SR, respectively) and Angus steers had higher ADG (P<.001) than Simmental steers and heifers (.85, .75 & .67 kg/d, respectively). Final carcass weights were not affected by SR (365, 358, 361±9 kg) or breed type and sex. Carcass weight was used as a covariate to analyze carcass data. Backfat thickness tended to be lower (P < .04) in low- and medium-SR calves than high-SR calves (.91, .85, 1.03±.08 cm). Rib fat content was lower (P < .006) in medium-SR calves compared to high-SR calves (26.0, 28.0±1.2%). Quality grades was (P = .006) lower for medium-SR calves than high-SR calves (620, 651±04). Shear forces after 14 and 35 days of aging were not affected by SR. Simmental-sired steers had lower backfat (.7 vs 1.0 and 9.9±.04), less rib fat (24.13 vs 28.99 and 28.60±.6%) than Angus x Brahman steers and Simmental-sired heifers. Quality grades and shear force values were not affected by breed type and sex class. In conclusion, decreasing pre-finishing growth rates of calves grazing ryegrass pasture by increasing SR, increased subsequent carcass fatness but did not affect meat tenderness.

Key Words: Beef, Background, Tenderness

667 Pork quality attributes associated with carcass side to side variation. C.A. Stahl^{*1}, M.L. Linville¹, M.A. Swaney-Stueve², K.R. Maddock¹, G.L. Allee¹, and E.P. Berg^{1, 1} *University of Missouri Department of Animal Science, Columbia, 2 University of Missouri Department of Food Science & Human Nutrition, Columbia.*

The objective of this study was to evaluate side to side variation in pork carcass quality. Barrows (n=56; 45 Kg) were fed a high-energy corn/soybean based diet ad libitum to a market weight of 118 Kg. Animals were slaughtered at the University abattoir. Immediately following electrical stunning, animals were shackled and hoisted by the right hind leg just prior to exsanguination. At 45 min. postmortem, intramuscular pH was taken (10th -11th rib) in both left and right side loins (L: 6.10 vs. R: 6.26 +/- .05, P<.05). 24-h postmortem pH measurements showed no significant loin variation (L: 5.48 vs. R: 5.51 +/- .02, P>.05). Whole loins were halved at the 10th rib and light reflectance measurements (Hunter L* a* b*) were taken on the cut lean surface of the sirloin, center, and blade sections at 24-36 hours postmortem. Differences in light reflectance were noted in the sirloin L* (L: 53.08 vs. R: 57.61 +/- .65, P<.05), center b* (L: 13.81 vs. R: 13.01 +/- .18, P<.05), and blade L* (L: 54.61 vs. R: 57.09 +/- .44, P<.05), a* (L: 7.37 vs. R: 6.26 +/- .15, P<.05), b* (L: 14.72 vs. R: 13.68 +/- .21, P<.05) values. Loins were then vacuum packaged and stored at 1 degree C for a duration of either 21 or 41 days to represent storage time required for delivery in domestic and export markets, respectively. Immediately following their allotment to storage, left/right loin sensory characteristics were evaluated by a descriptive attribute sensory panel (n=9) using a line scale of 1-10 (10 being the highest) for toughness and juiciness. Domestic loins (21d.) had a significant difference in toughness (L: 3.95 vs. R: 2.74, P<.05) and juiciness (L: 3.19 vs. R: 4.24, P<.05) while export loins (41d.) had a significant difference in toughness (L: 3.06 vs. R: 2.82, P<.05) yet no significance in juiciness. From this trial it can be concluded that significant differences in left/right variation exist within

a given pork carcass. This variation may be attributed to single leg shackling prior to exsanguination.

Key Words: Sensory Panel, Light Reflectance, Pork Quality

668 Conjugated linoleic acids (CLA) markedly modify fatty acid profile of fat tissues in growing pigs. G. Bee^{*}, *Swiss Federal Research Station for Animal Production, Posieux, Switzerland.*

CLA is the acronym for a class of positional and geometric conjugated dienoic isomers of linoleic acid. They were reported to profoundly affect lipid metabolism and to act as a repartitioning agent in a number of animal species. Up to date, little is known about their effect on the fatty acid profile of body fat in pigs. In the present study we determined the lipid composition of the back fat inner and outer layer and omental fat in 16 Large White pigs fed on diets supplemented either with 2% CLA or linoleic acid enriched oil (LA). The LA oil (66% linoleic acid) was prepared from sunflower oil and served as source material for the CLA oil. The isomers of the commercial preparation of CLA, containing 59% CLA isomers, were cis(c),trans(t)-9,11 (35%), t,c-10,12 (37%), t,t-9,11/10,12 (17%), c,c-9,11 (9%), and c,c-10,12 (2%). Animals were moved into individual pens at 70 kg live weight and fed 2.8 kg/d of a grower ration up to slaughter at 105 kg. Growth performance and carcass measurements were not affected by the dietary fat supplementation. Total lean and fat deposition was similar for both treatment groups. Unlike lipid content, fatty acid profile of the fat pad was markedly influenced by CLA. Independent of the tissue, pigs fed the CLA diet exhibited higher levels of palmitic (16:0) and stearic acid (18:0) (P < .05) and lower levels of palmitoleic (16:1), oleic (18:1), linoleic and arachidonic acid (P < .05). The levels of CLA isomers in back fat and omental fat were similar and do not indicate a preferential incorporation in either one of the tissues. The in vitro activity level of malic enzyme and fatty acid synthase was not altered by the dietary fat and the data suggest that lipogenesis was not affected by CLA. The distinct shift toward higher palmitic and stearic acid and lower palmitoleic and oleic acid concentrations, which resulted in significantly lower 16:1/16:0 and 18:1/18:0 ratios, could indicate a down-regulation of Δ 9-desaturase activity by dietary CLA. Furthermore, the lower tissue levels of arachidonic acid in the CLA group imply that Δ 5-desaturase activity might also be affected.

Key Words: Pigs, Conjugated Linoleic Acids, Fatty Acid Profile

669 Influence of dietary conjugated linoleic acid on meat quality and sensory traits of stress-genotype pigs. B.R. Wiegand^{*}, J.E. Swan, F.C. Parrish, Jr., and T.J. Baas, *Iowa State University, Ames.*

Growing-finishing pigs (n = 64) weighing 40 kg were fed a control diet or a diet containing 0.75% conjugated linoleic acid (CLA). Pigs were assigned to diets by stress-genotype (normal, carrier or positive). Pigs were harvested at 106 kg of body weight. Indicators of meat quality including postmortem pH decline, color, marbling, firmness, and sensory evaluation were analyzed for diet and genotype effects. A lower pH in the loin was detected at 3 h postmortem for stress-genotype pigs compared with normal and stress-carrier pigs. All pigs fed CLA exhibited a lower pH at 3 h postmortem compared with all control diet pigs. No differences were observed in subjective color scores for diet or genotype effects. Loins from all pigs fed CLA showed higher marbling scores compared with all control diet pigs. Marbling scores were higher in normal pigs compared with positive pigs, while carrier pigs were intermediate. Firmness scores followed the same results as marbling scores with respect to diet and genotype classes. Hunter L* values were higher for loins from CLA-fed pigs compared with control diet pigs, regardless of genotype class. No differences were observed for a* value due to CLA, but stress-positive, control diet pigs exhibited higher a* values compared with stress-carrier and normal genotype pigs fed the control diet. Loin chops from normal genotype pigs fed CLA had higher b* values compared with normal genotype, control diet pigs. No differences were observed for sensory attributes of juiciness, tenderness, or flavor intensity due to CLA supplementation. This study shows that pH is lower early postmortem with CLA supplementation. However, this aspect did not negatively influence characteristics of marbling or firmness. CLA supplementation significantly improved these meat quality attributes.

Key Words: Conjugated Linoleic Acid, Stress Genotype, Meat Quality

670 Compositional differences in bellies of CLA-fed stress genotype pigs as determined by TOBEC. J.E. Swan*, B.R. Wiegand, S.T. Larsen, F.C. Parrish, Jr., and T.J. Baas, *Iowa State University, Ames.*

Sixty-four crossbred growing-finishing pigs were placed on a control (soybean oil) or CLA (0.75%) diet until harvest. Pigs were penned in pairs according to diet and stress-genotype (negative, carrier or positive). Right and left side bellies were fabricated from carcasses at 24 h post-mortem with right side bellies being subjected to a belly bar firmness test, with higher lean up and lean down values constituting a firmer belly. All skin off bellies were scanned by TOBEC producing a Peak Mean Average (PMA) value. Predictions for protein, moisture, protein+moisture, and fat-free soft tissue (FFST) composition of bellies were performed and reported at R² of .67, .68, .71, .78, respectively. Belly bar firmness values were not affected by CLA, but negative pigs showed significantly higher firmness values than positive and carrier pigs (P<.05). Additionally, within the control diet, carrier pigs exhibited significantly lower lean down values than negative pigs (P<.05). Regardless of diet, positive and carrier pigs had higher moisture, and lower fat values compared with negative pigs (P<.05). Bellies from CLA supplemented pigs exhibited increased moisture and protein and decreased fat values compared with control fed pigs (P<.05). However, with genotype effect, only carrier pigs fed CLA had significantly higher protein values than control fed (P<.05). Within the control diet, bellies from positive pigs had significantly less fat and higher moisture values than negative genotype pigs (P<.05). Independent of diet, bellies from positive and carrier pigs had a higher TOBEC derived PMA value (P<.05) and FFST value (P<.05), than the negative genotype pigs. Changes in lean composition with dietary CLA could not be discerned with TOBEC analysis.

Key Words: TOBEC, Conjugated linoleic acid, Pork

671 Does creatine monohydrate supplemented to swine finishing rations affect pork quality? E.P. Berg¹, M.L. Linville*¹, C.A. Stahl¹, K.R. Maddock¹, and G.L. Allee¹, ¹*University of Missouri, Columbia.*

The objectives were to examine supplementing creatine monohydrate (CMH) in a complete swine-finishing ration and determine the effects on meat quality. Sixty pigs were allotted 3 pigs per pen and five pens per treatment. Treatment diets included 20g of CMH/ pig/ day fed for 5, 10 and 15 days prior to slaughter were compared to controls receiving no CMH. The basal diet was a traditional corn/soy finishing diet. Pigs (123 kg) were delivered to a commercial packing plant (31 km) and slaughtered according to industry practices. Carcasses were blast chilled and placed in the cooler for 24h. Right loins and hams were collected from the fabrication line, vacuum packaged, and boxed for delivery to the University Meat Lab. Ham pH and light reflectance (L*, a*, and b*) was obtained on the gluteus medius muscle. Hams were scanned for lean content by a primal cut electromagnetic scanner. Loin pH and light reflectance was obtained at the juncture of the 10/11th rib. The posterior section of the boneless loin was weighed, vacuum packaged, and stored for 7d at 3-degrees C. After 7-days aging, loins were unpackaged, weighed to calculate purge, and remeasured for light reflectance. Warner/Bratzler shear force was determined on 7d aged loin chops. Least squares means were calculated for each parameter and evaluated for linear, quadratic, and cubic contrast. A cubic trend (P=.08) was found for percent ham lean favoring longer duration supplementation of CMH. A linear trend (P=.07) was observed for ham L* (CON, 39.28; 5d, 41.82; 10d, 41.39; and 15d, 41.84). A cubic trend was observed for ultimate loin pH (P=.102) with controls and 5d higher than 10d and 15d. Hunter L*-values had a negative linear contrast (P<.01) after 7d aging (CON, 49.67; 5d, 48.71; 10d, 51.46; and 15d, 52.96). A cubic effect (P=.05) was shown for %moisture lost as purge (CON, 2.28; 5d, 1.50; 10d, 2.08; and 15d, 1.90%). Warner/Bratzler shear were different (P=.025) in a linear fashion (CON, 2.97; 5d, 2.95; 10d, 3.50; and 15d, 3.33 kg). It appears that supplementing creatine in swine diets longer than 5d reduces the quality of fresh pork.

Key Words: Pork Quality, Creatine Monohydrate, Supplement

672 The effect of Improvac on pork quality. D.N. D'Souza¹, D. Hennessy², M. Danby², I. McCauley³, and B.P. Mullan*¹, ¹*Agriculture Western Australia, South Perth, Australia,* ²*CSL Limited, Melbourne, Australia,* ³*Victorian Institute of Animal Science, Attwood, Australia.*

Improvac[®] (CSL Limited, Australia) is an immuno-castration vaccine directed against the pig's own gonadotropin releasing factor (GnRF) which eliminates boar taint. The aim of this study was to determine the effect of Improvac on boar taint (skatole and androstenone) and objective pork quality parameters (pH, colour, surface exudate and intramuscular fat). Forty loin muscle and backfat samples each from crossbred (Large White x Landrace x Duroc) entire male, female and Improvac vaccinated entire male pigs were collected 48h post-slaughter and assessed for boar taint, muscle pH, colour (Minolta L*a* and b*), surface exudate and intramuscular fat. Improvac vaccinated male pigs had lower backfat skatole and androstenone concentration compared to entire male pigs (skatole, 0.087 vs 0.193 ug/g, P=0.042; androstenone, 0.30 vs 1.12 ug/g, P=0.001). Pork from entire males and females had lower ultimate muscle pH compared to Improvac vaccinated male pigs (5.42 and 5.44 vs. 5.53, P=0.001). Entire male and female pigs had paler (L*) pork compared to Improvac vaccinated male pigs (51.9 and 54.8 vs. 49.8, P=0.001). Pork from Improvac vaccinated male and entire male pigs was redder (a*) compared to female pigs (7.47 and 7.74 vs. 6.80, P=0.044). Surface exudate measured using the filter paper method was lower for pork from Improvac vaccinated male pigs and entire male compared to pork from female pigs (39.5mg and 46.1mg vs. 54.8mg, P=0.001). Improvac vaccinated male pigs and female pigs had higher intramuscular fat in the loin muscle compared to entire male pigs (2.55 and 2.46 vs 1.66(%), P=0.010). The results from this study indicate that the Improvac vaccine, in addition to eliminating boar taint was also effective in improving the pork quality of male pigs.

Key Words: Immuno-castration, Boar taint, Pork quality

673 Pork quality and muscle characteristics of pigs finished indoors or outdoors during the winter months. J.G. Gentry*¹, J.R. Blanton¹, J.J. McGlone¹, J.L. Morrow-Tesch², and M.F. Miller¹, ¹*Texas Tech University, Lubbock, TX,* ²*USDA-ARS, Lubbock, TX.*

The objectives of this study were to determine the effects of diverse housing systems and exercise levels on pork quality and muscle characteristics. Forty-eight barrows were randomly selected from a group of indoor-raised pigs and placed on alfalfa pasture or indoors on a total slatted concrete flooring system during the winter months. The average starting weight of each group of pigs was 52 kg. Average daily gain was similar (P=.79) for the indoor and outdoor finished groups. Two groups of pigs (n=32) were randomly selected from the group of 48 for slaughter at the Texas Tech University Meat laboratory. After 24 hours of chilling, carcasses were ribbed between the 10th and 11th rib and allowed to bloom for 30 minutes. At this time, Hunter L*, a*, b*, NPPC color, firmness, and marbling scores were recorded on the *Longissimus dorsi* muscle. The pH decline of carcasses were also recorded. There were no differences in loin L*, a*, b*, color or marbling scores (P>.05). NPPC scores for firmness for the indoor and outdoor raised pigs were 3.37 and 2.62, respectively (P=.03). Measurements for 24 hr pH were 5.63 for the indoor group and 5.70 for the outdoor group (P=.05). Loin chops were cut after 7 and 14 days of aging. Pork loins were cut into 2.54 cm chops and frozen for further analysis. Warner-Bratzler shear force values for the indoor and outdoor raised pigs were not different (3.05 and 3.42 kg, respectively). There were no significant differences in sensory panel scores for tenderness, juiciness and flavor (P>.05) between the environments. Results from this study indicated that pigs finished in an outside pasture environment had similar growth and meat quality characteristics compared to pigs finished in a conventional slatted floor housing system. Further studies need to be conducted to determine if this trend remains over different seasons and for outdoor-born pigs.

Key Words: Pigs, housing system, meat quality

674 Modeling the probability of purchasing pork with specific quality traits. P. Chen, K. Koehler, T. J. Baas, and J.C.M. Dekkers, *Iowa State University, Ames.*

The objective of this study was to investigate the effects of meat quality traits, including ultimate pH, percentage of lipid (lipid%), and Instron

score on consumer preferences for pork. Data included preferences of 650 consumers toward purchasing pork versus chicken at a given price from a consumer preference study in 4 cities of pork loin from 12 breeds that was conducted by the National Pork Producers Council. Each consumer evaluated 4 pork samples. Regression analysis found significant effects of city, ultimate pH, lipid%, Instron score, and breed factors on evaluations of juiciness, tenderness, and flavor. This analysis used random consumer effects to account for correlations among multiple responses from individual consumers. A logistic regression model with city, ultimate pH, lipid%, Instron score, breed, the interaction between ultimate pH and breed (pH*breed), and the price ratio between pork and chicken (pratio) as fixed and consumer as a random effect was fitted to preference (0/1) data. Ultimate pH, lipid%, Instron score, breed, pH*breed, and pratio were found to be significant ($P < 0.05$). The odds ratio of purchasing pork instead of chicken increased 50% for each unit increase in lipid% and decreased 11% for each unit increase in the Instron score. A significant positive quadratic effect of ultimate pH was found, with greater odds ratios for pork with low and high pH, which was opposite from what was expected. Ultimate pH also exhibited the significant interaction with breed effects ($P < 0.05$). Pratio had a large effect on the odds ratio of buying pork over chicken. Results indicate that efforts to increase lipid% and to decrease Instron score can increase consumer preference for pork over chicken.

Key Words: Probability, Consumer preference, Meat quality trait

675 Supplemental vitamin D₃ improves beef tenderness. J. L. Montgomery^{*1}, J. G. Gentry¹, L. L. Behrends², E. R. Behrends², G. G. Hilton¹, M. Galyean¹, J. R. Blanton¹, A. Barham¹, B. Barham¹, and M. F. Miller¹, ¹Texas Tech University, Lubbock, ²Colorado State University, Fort Collins.

Feedlot steers (n=142) were supplemented one of four vitamin D₃ treatments for eight consecutive days prior to slaughter to characterize treatment effects on carcass traits and beef tenderness. A total of 48 pens of three steers each were utilized in a 4 X 3 factorial arrangement to study vitamin D₃ effects. The four vitamin D₃ treatments consisted (36 head/treatment) of no supplemental vitamin D₃, 1/2 million, 1 million, or 5 million IU/steer/d. The steers were classified as either a Bos taurus-British, Bos taurus-continental, or Bos indicus breed type. Average daily gain (ADG) and feed intake were reduced ($P < .05$) at the end of the feeding trial by supplementing 5 million IU/steer/d. Vitamin D₃ supplementation did not negatively affect lean color, yield or quality grade factors ($P > .05$). Thus, improvements in beef tenderness due to vitamin D₃ supplementation can be made without negatively affecting beef carcass quality and yield factors. Supplementing cattle with 5 million IU/steer/d of vitamin D₃ increased 24 h muscle pH and drip loss ($P < .05$). Supplementing steers with 1/2, 1, or 5 million IU/steer/d of vitamin D₃ resulted in elevated carcass temperatures at 3 h postmortem ($P < .05$). Vitamin D₃ treatments significantly reduced Warner-Bratzler shear force (WBS) of strip loin and inside round steaks at 7, 10, 14, and 21 d postmortem ($P < .05$). Reductions in WBS ranged from .7 to 1.0 kg for strip loin steaks and .4 to 1.1 kg for the inside round steaks. All vitamin D₃ treatments reduced WBS in strip loin steaks by 7 d postmortem when compared to controls ($P < .05$). For inside round steaks the largest reduction in WBS due to vitamin D₃ treatment was found at 3 d postmortem. While breed type affected ($P < .05$) many quality and yield factors, breed type and vitamin D₃ treatment did not interact ($P > .05$) for WBS values. Therefore, vitamin D₃ appears to affect beef tenderness of cattle from different breed types equally. Thus, vitamin D₃ treatments can reduce WBS up to 21 d postmortem when compared to non-supplemented samples. Supplementing steers with 1/2 and 1 million IU for 8 consecutive days can improve beef tenderness without negatively affecting ADG, feed intake, or carcass traits.

Key Words: Beef, Tenderness, Vitamin D

676 Characterization of muscle degradation from vitamin D₃ supplementation of feedlot steers using a muscle cell culture system. J. L. Montgomery^{*1}, K. J. Morrow¹, and M. F. Miller¹, ¹Texas Tech University, Lubbock.

Primary bovine muscle cell culture studies were conducted to determine whether supplemental vitamin D₃ has a direct effect on in vitro cellular protein synthesis and degradation. Feedlot steers (n=142) were supplemented one of four vitamin D₃ treatments for eight consecutive days prior to slaughter to characterize treatment effects on amino acid uptake

and protein degradation. The four vitamin D₃ treatments consisted (36 head/treatment) of no supplemental vitamin D₃, 1/2 million, 1 million, or 5 million IU/steer/d. The steers were classified as either a Bos taurus-British, Bos taurus-continental, or Bos indicus breed type. At slaughter serum was collected on each of the individual steers. Muscle samples were collected from the longissimus lumborum at 1-h postmortem for extraction and incubation with primary bovine muscle cells. Each muscle sample was a 10-g sample of muscle, free of fat and connective tissue extracted in 50 mM Tris and 10 mM EDTA with leupeptin, ovomucoid, and PMSF to inhibit proteolysis. Myoblast cultures were pretreated with serum and muscle extracts for 24 h before a 4-h synthesis or 6-h degradation measuring period. Serum samples did not differ in amino acid uptake or protein degradation. Amino acid uptake of muscle extracts was also not affected by vitamin D₃ treatment or breed type. There was a vitamin D₃ X breed type interaction for protein degradation of muscle extracts ($P < .05$). Protein degradation from the muscle extracts was increased ($P < .05$) if steers had been treated with 5 million IU/d compared to the non-supplemented feeding regime. All of the vitamin D₃ treated steers of the Bos taurus-British breed type had increased ($P < .05$) muscle degradation when compared to control steers of the same breed type. Treating steers from the Bos-taurus-continental and Bos indicus breed types with 1/2 or 1 million IU/steer/d of vitamin D₃ resulted in a minimal effect on cellular protein degradation from muscle extracts ($P > .05$). These results indicate that in some breeds a high concentration of supplemental vitamin D₃ may function through a secondary mechanism in muscle to increase muscle protein degradation.

Key Words: Muscle cells, Vitamin D, Protein degradation

677 Carcass and palatability traits of steer progeny of Hereford, Angus, Norwegian Red-Swedish Red and White, Friesian, and Wagyu sires. T. L. Wheeler^{*}, L. V. Cundiff, S. D. Shackelford, and M. Koohmaraie, USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.

For carcass traits, data were obtained for 576 steers resulting from artificial insemination matings of Hereford (H, 32), Angus (A, 30), Norwegian Red-Swedish Red and White (NS, 14 and 16, respectively), considered the same breed because of open herd books), Friesian (F, 24 non-Holstein influenced), and Wagyu (W, 19) sires to Hereford, Angus, and composite MARC III dams. For Warner-Bratzler shear force and trained sensory panel traits, data were obtained for 337 and 261 longissimus steaks, respectively. Carcasses from H- and A-sired steers (377 and 374 kg, respectively) were the heaviest ($P < 0.05$) and carcasses from W-sired steers (334 kg) were the lightest ($P < 0.05$). A greater ($P < 0.05$) percentage of carcasses from A- and W-sired steers graded USDA Choice (88 and 85%, respectively) than carcasses from other sire breeds (52 to 71%). Adjusted fat thickness for carcasses from A-sired steers (1.3 cm) was highest ($P < 0.05$), followed by H-sired steers (1.1 cm), then W- and F-sired steers (0.9 cm), and NS-sired steers (0.8 cm). Longissimus area was not different ($P > 0.05$) among sire breeds (mean = 80.6 cm²). Carcass yield of boneless, totally trimmed retail product was lowest ($P < 0.05$) for A-sired steers (60.1%), intermediate for H-sired steers (61.5%), and similar ($P > 0.05$) for all other sire breeds (62.5 to 62.8%). Longissimus from carcasses of A- and W-sired steers had lower ($P < 0.05$) shear force values (3.7 kg) than longissimus from other sire breeds (4.1 to 4.2 kg). Trained sensory panel tenderness, juiciness, or beef flavor intensity ratings for longissimus were not different ($P > 0.05$) among the sire breeds. Relative to the other sire breeds, W-sired steers had the highest percentage of USDA Choice yield grade 1 and 2 carcasses with similar longissimus tenderness.

Key Words: Beef, Breed, Quality

678 The effect of Wagyu and Limousin genetics on factors associated with tenderness. P. S. Kuber^{*1}, J. R. Busboom¹, J. G. Nordyke¹, S. K. Duckett², P. S. Mir³, Z. Mir³, J. D. Cronrath¹, K. A. Johnson¹, J. J. Reeves¹, and C. T. Gaskins¹, ¹Washington State University, Pullman, ²University of Idaho, Moscow, ³Agriculture and Agrifood Canada, Lethbridge, AB.

The objective of this study was to evaluate longissimus muscle (LD) samples from 12 Wagyu (W), 12 Wagyu X Limousin (WXL) and 12 Limousin (L) cattle for attributes affecting tenderness. A 2x3 factorial arrangement of treatments, with the main effects breed and diet, were analyzed using GLM procedures. Cattle were fed barley-based backgrounding and finishing diets with either 6% supplemental sunflower oil

or no added oil, for an average of 259 d. Cattle were humanely slaughtered and samples were collected at 24 h postmortem (PM), vacuum packed and aged at 2°C (1, 3, 7, 14, 28 and 56 d). Samples were then frozen at -40°C, after aging for later analysis. Day 0 calpastatin activity (CA) did not differ ($P > .05$) between breeds. Repeated measure analysis showed that the effect of PM aging on Warner-Bratzler shear force (WBS) was significant ($P < .05$); a 2 kg difference was detected from 1 d (5.12 kg) to 56 d (3.14 kg) of aging. The overall effect of breed for WBS indicated that W were more tender than L ($P < .05$). Although not significant ($P > .05$), W had higher WBS values at 1 d PM than did WXL or L, but by d 14, WBS values for W were .767 kg less ($P < .05$) than for L. The WXL did not differ in WBS from the other breeds. Breed did not affect ($P > .05$) free calcium levels (FCL), measured at 0, 1, 3, 7 and 14 d PM. In all breeds, FCL concentrations were approaching levels ($>300 \mu\text{Mol}$) necessary to activate m-Calpain by 7 d PM. An overall breed effect was detected for the rate of temperature and pH decline ($P < .05$). Wagyu were slower in pH and more rapid in temperature decline than WXL or L, yet no difference existed at 24 h PM. Steaks from W had lower WBS values than L at d 14, however CA (0 d) and FCL do not explain this result.

Key Words: Tenderness, Calpastatin Activity, Free Calcium

679 Anabolic implants and meat tenderness. C.W. Wiltbank^{*1}, E.W. Hawkins¹, D.K. Lunt², and T.E. McCullum², ¹Brigham Young University, Provo, ²Texas A&M University, College Station.

A total of 438 Angus crossbred steer and heifer calves of similar genetic makeup were randomly assigned to five treatments to determine the effect of anabolic implants on meat tenderness. Treatments consisted of: (1) no implant, (2) no implant at branding (6 weeks of age) + Synovex S or H at weaning (8 mo of age) + Synovex S or H 90 d later, (3) no implant at branding + Synovex S or H at weaning + Synovex Plus 90 d later, (4) Synovex C at branding + Synovex S or H at weaning + Synovex S or H 90 d later, (5) Synovex C at branding + Synovex S or H at weaning + Synovex Plus 90 d later. Calves were produced on three different ranches and were transported to a growing yard at weaning (206 kg \pm 29.38). When calves reached 341 kg live wt. they were transported to a feed lot where they were put on a finishing ration for approximately 90 d and slaughtered. USDA quality and yield grade factors were obtained and samples of strip loins were taken from each carcass. Each sample was aged for two weeks at 2°C prior to being frozen until they could be shear tested. The meat was prepared and sheared following research guidelines published by the American Meat Science Association. Six cores were taken from each sample and were analyzed via Warner-Bratzler Shear methodology. Statistical analysis was performed using analysis of variance. The effects of treatment, ranch, sex and slaughter group were evaluated. There was no difference in shear force between the five treatment groups ($P > .05$). However differences in shear force due to ranch, sex, and slaughter group were detected ($P < .05$). It was noted that over 98% of the strip steaks, regardless of implant treatment, sex or ranch of origin, required < 4.55 kg of shear force.

Key Words: Tenderness, Implants

680 Correlations among selected pork quality traits in a Berkshire by Yorkshire F2 population. E. Huff-Lonergan^{*}, T. J. Baas, M. Malek, J. Dekkers, K. Prusa, and M. F. Rothschild, Iowa State University, Ames.

Mechanisms underlying the development of pork quality traits are elusive. Establishing relationships among specific quality traits is important if significant progress toward genetic selection for meat quality is to be realized. As part of a study to examine the individual effects of genes on meat quality traits in pigs, a three-generation resource family was developed. Two Berkshire sires and ten Yorkshire dams were used to produce ten F1 litters. Sixty-five matings were made from the F1 litters to produce four sets of F2 offspring for a total of 525 F2 animals that were used in the study. These F2 animals were slaughtered at a commercial facility at approximately 110 kg. Loin samples ($n = 525$) were collected at 48 hours postmortem and meat quality traits were evaluated. These quality traits included (but were not limited to): Hunter L values (HL), pH, drip loss (DL), glycolytic potential (GP), Star probe measurement of instrumental tenderness (InTen), and total lipid content (TLp). Mean values and standard deviations (SD) for these traits are as follows: HL (46.87, SD 3.39), pH (5.83, SD 0.19), DL (5.84%, SD 1.99), InTen (4.36

kg, SD 0.86), and TLp (3.23%, SD 1.32). Ratio of TypeIIa/IIb muscle fibers (IIa/IIb) was also evaluated. InTen was significantly correlated ($P < .01$) to DL (0.29), GP (0.30), pH (-0.29), TLp (-0.14) and HL (0.28). DL was significantly correlated ($P < .01$) to GP (0.36), pH (-0.28), IIa/IIb (-0.10, $P < .05$), and HL values (0.33). HL values were also significantly correlated to TLp (0.33, $P < .01$) and IIa/IIb (-0.11, $P < .05$). These data suggest that improvements in some meat quality traits may have an effect on other meat quality attributes. This work was supported by an industry consortium of the National Pork Producers Council, the Iowa Pork Producers Association, the Iowa Purebred Swine Council, Babcock Swine, Danbred USA, DEKALB Swine Breeders, PIC, Seghersgenetics USA, and Shamrock Breeders.

Key Words: Pork, Meat quality

681 Quality characteristics of PSE hams. C. Perez-Linares¹, A. Alarcon-Rojo^{*1}, and J. Jimenez-Castro¹, Universidad Autonoma de Chihuahua. Chihuahua, Chih. Mexico.

Two experiments were conducted to evaluate the use of pale, soft and exudative (PSE) pork in restructured hams. The objective of experiment 1 was to evaluate the physicochemical, microbiological and sensory quality of hams containing 0, 10 and 20% PSE pork and stored for 1, 7 and 14 d at chilling temperatures. The objective of experiment 2 was to evaluate the quality of 20% PSE hams with the addition of a carrageenan-containing water binder. There was no effect ($p \geq .05$) of PSE-meat level and storage time on color (L*, a*, b*), pH, shear force, water-holding capacity, and total protein of hams. Vacuum packaged restructured hams stored at 4°C had similar ($p \geq .05$) aerobic and anaerobic mesophiles and psychrophiles counts regardless of PSE level or storage time, averaging 3.44, 3.30 and 2.71 log₁₀ CFU/g, respectively. Sensory quality of PSE hams (appearance, color, texture and flavor) did not differ ($p \geq .05$) from the control hams, but 20% PSE hams showed the highest ($p \leq .05$) cooking (1.05%) and storage losses (1.90% at d 14). The addition of PSE meat decreased ($p \leq .05$) ham pH at day 1 of storage (5.90) but it remained constant through the storage time ($p \geq .05$). The addition of carrageenan did not change ($p \geq .05$) water-holding capacity, shear force, color and sensory quality of both normal and PSE hams, though it decreased ($p \leq .05$) cooking (-.87%) and storage losses (- 2.50%) of hams. The results of this study suggest that the addition of up to 20% PSE meat and carrageenan to restructured hams had no detrimental effect on product quality.

Key Words: PSE pork, Ham, Quality

682 Relationship of beef carcass traits to chemical and tissue composition of rib samples by X-ray computer tomography. G. Hollo¹, F. Szabo^{*2}, E. Szuecs¹, J. Tözsér¹, J. Csapo³, B. Huth³, and I. Hollo³, ¹Szent Istvan University, Godollo, ²University of Veszprem, Georgicon Faculty, Keszthely, ³University of Kaposvar, Faculty of Animal Science, Hungary.

Due to its measures, in vivo estimation of beef carcass composition by X-ray computer tomography does not seem to be feasible. The aim of this study was if there is an opportunity for indirect estimation of tissue composition and/or carcass value from samples taken from beef carcass by means of CT. Animals ($N=136$) of various breeds (Holstein-Friesian (HF), Hungarian Red Spotted (HRS) and HRS x HF crossbreds) and sexes (heifers, bulls and culled cows) were slaughtered at different weights (range 270-790 kg). In addition to data recorded at slaughter samples were taken after 24 hrs. chilling from 11-13th ribs of right half carcasses and examined by Siemens Somatom Plus S40 spiral CT in two measuring steps for tissue composition. Just the same samples were used for chemical analysis. Moisture, protein, intramuscular fat and crude ash content were determined by standard procedure. Statistical analysis was made by SPSS 8.0 for Windows (1997), where coefficients of correlation were estimated among parameters registered. Close association among tissue composition traits of carcasses and that of rib samples were established. Highest coefficients of correlation were found for amount of percentage of kidney fat, carcass fat and intermuscular fat of rib samples ($r = 0.91$; 0.83 and 0.92 , resp., $P < 0.001$). Coefficients of correlation for amount of bone and muscle in carcass and in rib samples were $r = 0.76$ and 0.87 , resp. ($P < 0.001$), and a negative relationship of protein to fat content in rib samples was established ($r = -0.95$, $P < 0.001$). Similar tendencies were present for the amount of fat recorded at slaughter and protein content of rib samples ($r = -0.84$ - $r = -0.85$, $P < 0.001$). The amount of fat in carcasses and/or kidney fat

showed obvious and positive association to fat content of rib samples. Relationships of tissues (muscle, bone and fat) in rib samples determined by CT seemed to be higher than that of estimated by tissue separation of carcasses. Coefficients of correlation were $r = 0.80$; 0.66 and 0.94 in the former and $r = 0.64$; 0.52 and 0.91 in the latter case ($P < 0.001$). In conclusion, using X-ray tomography for tissue composition of rib samples can effectively be used for estimation of tissue composition of beef carcasses.

Key Words: Composition of beef carcass, X-ray computer tomography, Chemical composition of rib samples

683 Comparison of two different containers for performing hydrodynamic pressure process. M.B. Solomon* and B.W. Berry, USDA, ARS, MSRL.

Hydrodynamic pressure processing (HDP) has been shown to instantaneously improve tenderness of meat cuts. This process has typically been performed in either 208 L, 115 L, 98 L disposable plastic containers (PEC) or in a 1060 L stationary steel chamber (HU). A small scale (54 L) model (mini-HU) of the HU was constructed for laboratory tests. Tenderness improvement in USDA Select grade boneless strip loins was assessed by application of HDP in either 115 L PECs or the 54 L mini-HU ($n=24$). Quantity of explosive was adjusted according to the distance to the bottom of each container in an attempt to generate similar pressure fronts entering the meat samples. Treated and control samples were cut into 2.5 cm thick steaks after being HDP treated and cooked to 71 C on open-hearth electric broilers. HDP generated in the PEC resulted in 40% improvement in shear force compared to controls (6.76 vs 4.08 kg). Samples treated in the mini-HU improved 28% compared to controls (6.76 vs 4.88 kg). Results suggest that although HDP does improve tenderness, the magnitude of improvement is conditional on the configuration and composition of the container and may be dependent on other parameters yet to be determined.

Key Words: Beef, Tenderness, Hydrodynamic Pressure Process

684 Tenderizing meat from Brahman cattle: Hydrodynamic pressure process and within-muscle effects for bottom round. J. S. Eastridge*¹, M. B. Solomon¹, R. L. West², and C. C. Chase, Jr.³, ¹USDA, ARS, Beltsville, MD, ²Univ. of Florida, Gainesville, ³USDA, ARS, STARS, Brooksville, FL.

Hydrodynamic pressure (HDP) has been used successfully to tenderize meat. A HDP shock wave is generated from an underwater detonation of a small amount of explosive. The wave passes through vacuum packaged meat that is also underwater until it encounters a reflective surface or 'boundary' of different acoustic properties than water. At the boundary, the shock wave essentially turns back to pass a second time through meat, thus impacting tenderness. In the single-use plastic explosive container (PEC) a steel plate is used in the bottom to provide a reflective boundary; however, there is an air boundary outside the PEC which has not been explored for its impact on HDP process. This 2 x 2 factorial study was designed to evaluate the depth of the air boundary outside the PEC on the tenderization response within the bottom round (BR) from Brahman cattle. Six whole BR (shipped fresh from Gainesville, FL to the USDA lab in Beltsville, MD then frozen at 7 d postmortem) were thawed 40 hr at 4° C and a 3-cm thick steak for control (CON) was cut from the middle of each BR. The remaining heel and caudal halves were randomly assigned to HDP treatment (100 g explosive placed 30 cm from the meat) in a PEC suspended in air to create boundary depth of 23 or 37 cm. After HDP, three to four 3-cm steaks were cut from each half for 39 paired comparisons (CON vs HDP). All steaks were cooked to internal temperature of 71° C on an electric grill. An interaction ($P < .03$) between BR half and air boundary depth was noted for shear force after HDP treatment. Shear force of heel portion HDP treated at 23 cm air (5.7 kg) was not different from CON (6.1 kg) whereas all other paired comparisons resulted in lower ($P < .05$) shear force after HDP. Shear force values for CON vs HDP were: 8.0 vs 6.3 kg for heel at 37 cm; 7.8 vs 6.2 kg for caudal at 23 cm; 8.1 vs 5.0 kg for caudal at 37 cm. The 28.6% improvement in shear force in the BR caudal half was more than double that in the heel portion (13.8%). A deeper air boundary (37 cm) resulted in a greater ($P < .01$) reduction in shear force (29.3%) when compared to 23 cm boundary depth (13.2%). Understanding factors that affect the performance of HDP will aid in

equipment design and allow for the optimization of HDP for meat tenderness enhancement.

Key Words: Tenderness, Hydrodynamic pressure, Brahman

685 Application of hydrodynamic pressure processing for further processed meat products. B. W. Berry*¹, M. B. Solomon¹, and A. G. Senecal², ¹ARS-USDA, Beltsville, MD, ²US Army Natick R, D & E Center, Natick, MA.

Hydrodynamic pressure processing (HDP) has produced considerable tenderness improvements in fresh meat cuts. The high moisture content of fresh muscle has been thought to be instrumental in achieving this tenderness improvement with HDP. The objective of this study was to ascertain whether HDP could affect tenderness/texture properties of further processed, lower moisture meat products. Shelf-stable beef and chicken sticks (50%fat) were subjected to HDP in either 115 L disposable plastic containers (PEC), a 1060 L stationary steel chamber (HU) or a smaller 54 L stationary unit (SHU). Meat sticks ($n=37$ to 60 depending on test) were subdivided, repackaged, subjected to HDP and evaluated for shear force. HDP reduced ($P \leq .05$) shear force with HU producing a greater reduction than PEC and SHU. In a second study, U.S. Select and Choice beef loin and round muscles were subjected to HDP using PEC and HU systems prior to cutting into steaks, freeze-drying, rehydrating, cooking and measuring tenderness with various instrumental measures. HDP resulted in lower ($P \leq .05$) peak shear force and time to attain peak shear (Choice knuckles only) both before and after freeze-drying. With U.S. Select strip loins, HDP generated in PEC produced tenderness improvements (peak load, punch and die) $\geq 40\%$ both before and after freeze-drying. HDP resulted in a decrease in protein solubility in these samples. These studies illustrate that HDP has the potential of altering tenderness/texture properties in further processed meat products.

Key Words: Processed meats, Hydrodynamic pressure, Shear force

686 Intramuscular collagen properties of longissimus muscle of *Bison bison*. G. Maiorano*¹, F. Filetti¹, R. J. McCormick², D. C. Rule², and A. Manchisi¹, ¹Universiti degli Studi del Molise, Campobasso, Italy, ²University of Wyoming, Laramie.

The objective of this study was to determine intramuscular collagen properties in *longissimus* muscle of 31 mo-old bison bulls (*Bison bison*) raised on grass and 18-mo old bison bulls fed a high-concentrate diet for 6 mo. *Longissimus* samples were taken from the 12th rib 14 d post mortem of 10 bulls of each feeding regimen. *Longissimus* samples also were taken from carcasses of 10 crossbred beef steers finished on a high-concentrate diet. Carcasses were held at 2 to 4° C. Muscle samples were lyophilized and then hydrolyzed in 6N HCl for analysis of hydroxyproline and hydroxylysylpyridinoline (HLP) crosslink. Collagen concentration was calculated assuming that collagen weighed 7.25 times the measured hydroxyproline weight. HLP crosslink concentration of intramuscular collagen was determined by reverse phase HPLC. Grain- and grass-fed bison *longissimus* had similar ($P > .05$) amounts of collagen (15.4 and $15.9 \pm .6 \mu\text{g}/\text{mg}$ of muscle, respectively) and similar ($P > .05$) HLP concentrations (.31 and $.34 \pm .01 \text{ mol}/\text{mol}$ of collagen, respectively). Total collagen of beef steer *longissimus* ($15.6 \pm .6 \mu\text{g}/\text{mg}$ of muscle) was similar ($P > .05$) to that of grain-fed bison. However, HLP was 25% greater ($P < .05$) in beef cattle *longissimus* ($.39 \pm .02 \text{ mol}/\text{mol}$ of collagen) than in grain-fed bison. Results suggest that grain-fed and grass-fed bison *longissimus* intramuscular collagen could have a similar stabilization degree due to similar HLP crosslink concentrations; however, bison *longissimus* intramuscular collagen may be more immature than that from beef cattle due to lower HLP crosslink concentrations in the bison muscle.

Key Words: Bison, Intramuscular Collagen, Beef Cattle

687 Influence of diet on amino acid profiles of two muscles in chianina beef. F Nicastro*¹, R Gallo¹, A Caputi Jambrenghi¹, and L Zezza¹, ¹Department of Animal production, University of Bari, Bari, Italy.

The amino acid composition of beef is an important factor in the human diet. This study relates to differences observed in amino acid profile and chemical composition content in two muscles of beef. Twenty cattle Chianina males, six months old, were divided equally into two treatment

groups for energy level (High=10.5 and Low=8.3 ME/kg DM). The animals from each group were slaughtered at 8 months of age. Samples of longissimus thoracis (Lt) and semimembranosus (Sm) muscles were removed from the carcasses 4h after slaughter and stored at -80° C until they were analyzed. The aminoacids (Aspartic acid, Glutamic acid, Serine, Threonine, Alanine, Arginine, Proline, Phenylalanine, Leucine and Isoleucine, Valine, Methionine, Histidine, Lysine, Tryptophan and Glycine) were quantified by means of chromatographic technique and the protein was determined by Kjeldahl nitrogen analysis. Data were tested following the SAS programme using the General Linear Models procedure. In general, data presented similar profiles in both muscles, in the two treatment groups, with only a few significant differences. Lt muscle of animals fed in group H had higher values for glutamic acid ($P < 0.01$) and aspartic acid ($P < 0.05$). Lt contained a higher amount of ether extract and protein when compared to Sm. The results of this study indicate that the levels of energy of the diet as used in this trial did not influence the profile of the amino acids in the two muscles at this age.

Key Words: Beef, Chemical composition, Diet

688 Fiber type (Myosin Heavy Chain I) and biochemical traits of *Longissimus thoracis* from three European beef breed types. M. Gil¹, X. Serra¹, M.A. Oliver¹, C. Sa'udo², J.L. Olleta², M.D. Garcia-Cachn³, M.C. Olivn³, M.M. Lopez-Parra⁴, R. Quintanilla⁵, and J. Piedrafita⁵, ¹IRTA- CTC, Monells, Spain, ²Univ. Zaragoza, Zaragoza, Spain, ³ETC, Guijuelo y CIATA, Villaviciosa, Spain, ⁴SIAEX, Badajoz, Spain, ⁵UAB, Barcelona, Spain.

The effect of the breed type on some chemical and biochemical traits (intramuscular fat (IMF), haem pigment, myosin heavy chain I (MHC-

I), lactate dehydrogenase and isocitrate dehydrogenase (ICDH) activities) of muscle *longissimus thoracis* (LT) from seven European beef breeds was studied. The animals (478) were fattened with concentrate *ad libitum* and straw from 7 to 12-18 months depending upon breed-production system. Breed-production systems were grouped into three types: 1) Fast growth rate (FG) (n=199, carcass weight, CW, 312.9 ±36.7 kg), 2) double muscle condition (DM) (n=70, CW, 324±21.8 kg) and 3) rustic characteristics (RC) (n=208, CW, 265.1±26.7 kg). MHC-I was determined by enzyme-linked immunosorbent assay using a specific MHC-I monoclonal antibody. A least squares analysis including the effect of breed type was performed using the GLM procedure of the SAS. The breed type influenced all the muscle characteristics studied. The three groups showed different average daily gains (ADG) (LSM±SE, 1.64±0.02 (FG), 1.41±0.04 (DM) and 1.30±0.02 (RC) kg/day). The animals from the DM group had the highest lean percentage (76±0.6%) and the lowest IMF percentage (0.99±0.14%) whereas the RC breeds showed the opposite (65.5±0.35% and 2.64±0.08% for lean and IMF, respectively). The most oxidative traits were found in the RC group (MHC-I, 35.3±0.9%). ADG was negatively correlated with pigment content and ICDH in the FG group of animals, but this was not observed in the other groups. MHC-I presented a positive and significant correlation with respect to pigment content in the three groups studied, indicating that muscles with a higher MHC-I content had a higher myoglobin content and, consequently, were more oxidative. The differences in muscle characteristics found in the three breed types suggest differences in the technological and sensorial characteristics of their meat quality.

Key Words: Breed type, Myosin I, Intramuscular fat

MILK SYNTHESIS

689 Estrogen treatments to initiate dryoff in dairy cows. M.L. Schairer*, K.C. Bachman, M.J. Hayen, and H.H. Head, University of Florida Gainesville.

Mammary involution in dairy cows is accelerated by exogenous estrogen. Estradiol-17β (E₂) and estradiol-17β cypionate (ECP[®]) were evaluated to determine their effectiveness in promoting mammary involution as monitored by the decline in daily milk yield. Response of pregnant, lactating dairy cows (n=5) to 4 consecutive once-daily injections of E₂ (E4x15; 15mg/d, s.c.) served as the positive control for intramuscular ECP treatments of 20 and 30 mg administered via single injection (ECP1x30, n=4; ECP1x20, n=5) or two once-daily injections (ECP2x15, n=6; ECP2x10, n=5). Cows were milked thrice daily before and after the injections which were begun at the onset of projected 60d dry periods. Milk production (kg/d) for E4x15 and ECP treatments (1x30, 2x15, 1x20, 2x10) before injection and on day 7 post-first injection were: 19.9, 21.0, 20.0, 21.6, 17.8 and 7.8, 8.4, 8.0, 10.6, 12.7. Thus, daily milk yields declined 60.9, 60.0, 60.1, 51.0, and 29.0 percent despite the thrice daily milkings. Average daily high ambient temperature and minimum relative humidity were 32.8°C and 57%. This heat stress plus the physical stress and oxytocin stimulation associated with the milk removal activity, as well as, stage of gestation at estrogen treatment, were considered possible contributors to the abortion events that occurred. Days post-injection at which 6 cows aborted were: E4x15, n=2 (7,8); ECP1x30, n=1 (15); ECP1x20, n=1 (12); and ECP2x10, n=2 (9,11). During a second experiment, at final milk removal, thirty pregnant, lactating cows projected to have 30d dry periods received one i.m. injection of ECP: (cottonseed expient, n=10; 30 mg, n=10; or 20 mg, n=10). Abortion did not occur. In contrast to the previous cows, these cows received ECP later in gestation (250vs220 d pregnant) and were not milked post-injection. Also, they experienced less heat stress, in that, both temperature (26.2°C) and humidity (56%) were lower. Results suggest that ECP[®] administered at dryoff might allow the length of the non-income producing dry period to be shortened profitably.

Key Words: Estrogen, Dry period, Involution

690 Exogenous *trans*10,*cis*12-18:2 reduces *de novo* synthesis and desaturation of milk fatty acids in cows fed diets supplemented with high-oleic or high-linoleic oil. J. J. Loor* and J. H. Herbein, Virginia Polytechnic Institute & State University, Blacksburg.

To determine the effects of an elevated supply of *c9,t11-18:2* (CLA9/11) or *t10,c12-18:2* (CLA10/12) on milk fat concentration and fatty acid profiles, four Holstein cows fed oil (2.5% of DM) were infused (0.625 g/h) with CLA9/11 (90% pure) or CLA10/12 (95% pure) for 48 h via the abomasum. High-oleic safflower (HO; 70% *c9-18:1*) or high-linoleic safflower oil (HL; 65% *c9,c12-18:2*) were used as oil supplements. Treatments were assigned in a 2 × 2 factorial design. Cows were fed the assigned diets for 11 d prior to each 48-h infusion period. During the 7-d transitions between periods, all cows were fed a diet supplemented (2.5% of DM) with equal proportions of HO and HL. Milk samples were obtained at -12 and 0 h before infusion, at 12, 24, 36, and 48 h during infusion, and at 60, 72, 84, and 96 h after infusion. Milk yield and DMI were not affected by treatment. Percentages and yields of protein, lactose, and SNF in milk also were not affected by treatment. Milk fat percentages from 24 to 96 h were lower in response to CLA10/12 (2.7, 2.4, 2.3, 2.2, 2.1, 2.5, and 2.7%) compared with CLA9/11 (3.3, 3.2, 3.4, 3.5, 3.4, 3.5, and 3.4%) regardless of diet. Fat yield also was lower in response to CLA10/12. Concentration of *c9,t11-18:2* in milk fat before infusion was higher when HL (9 mg/g total fatty acids) was fed compared with HO (6 mg/g), and it increased to 15 or 11 mg/g by 48 h of CLA9/11 infusion in cows fed HL or HO. Although *t10,c12-18:2* was not detectable in milk fat before infusion, it accounted for 6 mg/g by 48 h of CLA10/12 infusion. Regardless of diet, concentration of saturated fatty acids with 4 to 16 carbons decreased from 410 mg/g at 0 h to 350 mg/g at 48 h of CLA10/12 infusion, whereas concentration of 18:0 increased from 144 mg/g at 0 h to 210 mg/g at 48 h. Concentration of *t11-18:1* in milk fat (9 or 16 mg/g for HO or HL) before an infusion was greater when HL was fed, and infusion of CLA10/12 caused a further increase in concentration by 48 h (15 or 18 mg/g for HO or HL). Ratios of 18:0 to *c9-18:1*, *t11-18:1* to *c9,t11-18:2*, and *c9,c12-18:2* to 20:4 in milk fat increased from 0.5, 1.7, and 18 at 0 h to 0.8, 2.7, and 25 at 48 h of CLA10/12 infusion regardless of diet. Increased *t10,c12-18:2* availability and uptake by the mammary gland reduced *de novo* fatty acid synthesis and desaturation of 18-carbon fatty acids.

Key Words: CLA, Trans fatty acids, Milk fat

691 Effect of conjugated linoleic acids (CLA) on lipid metabolism in lactating dairy cows. L.H. Baumgard*, B.A. Corl, D.A. Dwyer, T.R. Mackle, and D.E. Bauman, *Cornell Univ., Ithaca, NY.*

CLA have been shown to affect a large number of biological processes including lipid metabolism. Administration of CLA to lactating dairy cows causes milk fat depression, and we demonstrated this is specific for the *trans*-10, *cis*-12 isomer (Baumgard et al., *Am. J. Physiol.* 278:R179). In the present study we evaluated the effects of CLA isomers on lipid fractions and verified effects on milk fat synthesis and composition. Three Holstein cows (183 ± 8 DIM) were utilized in a 3x3 Latin square design. Treatments consisted of 5-d abomasal infusion of 1) control, 4L of skim milk/d, 2) 9,11 CLA, 10 g/d of *cis*-9, *trans*-11 CLA isomer and 3) 10,12 CLA, 10 g/d of *trans*-10, *cis*-12 CLA isomer. Blood samples were obtained on d 5 of each period and performance data represent d 4 and 5 of infusion. Treatments had no effect on DMI (26 kg/d), milk yield (32 kg/d), milk protein yield (923 g/d) or protein percentage (2.94). Compared to control and 9,11 CLA treatments, the 10,12 CLA resulted in a 31% reduction in milk fat yield (1034^a , 1106^a , 742^b g/d) and a 29% decrease in milk fat percentage (3.22^a , 3.44^a , 2.36^b) ($P < 0.05$). Relative to control, infusion of the 9,11 CLA increased the *cis*-9, *trans*-11 concentration in plasma phospholipids (0.3^a vs. 2.5^b mg/g) and plasma triglycerides (1.4^a vs. 3.8^b mg/g). Likewise *trans*-10, *cis*-12 levels were undetectable in controls but infusion of 10,12 CLA increased levels to 1.8 mg/g in plasma phospholipids and 2.7 mg/g in plasma triglycerides. These CLA isomers were not detected in other plasma lipid fractions (< 0.1 mg/g). An examination of milk fat composition indicated de novo synthesized fatty acids accounted for 69% of the total reduction in milk fat yield (molar basis) observed with the 10,12 CLA treatment. In addition, ratios of $C_{14:0}/C_{14:1}$, $C_{16:0}/C_{16:1}$, $C_{18:0}/c9-C_{18:1}$ and $t11-C_{18:1}/c9,t11-CLA$ were significantly increased during the 10,12 CLA treatment. We have verified the inhibitory effects on milk fat synthesis are unique to the *trans*-10, *cis*-12 isomer and that both CLA isomers were incorporated into plasma phospholipid and triglyceride fractions.

Key Words: CLA

692 Conjugated linoleic acids as free fatty acids or triglycerides cause milk fat depression. T. W. Hanson*¹, J. G. Giesy¹, M. A. McGuire¹, E. L. Annen¹, D. E. Bauman², A. Saebo³, and M. K. McGuire⁴, ¹University of Idaho, Moscow, ²Cornell University, Ithaca NY, ³Natural Lipids, Norway, ⁴Washington State University, Pullman.

Conjugated linoleic acids (CLA) have been shown to be potent inhibitors of cancer in many animal models. Further, commercial mixtures of CLA isomers have been found to depress milk fat synthesis in cows, humans and pigs. These commercial mixtures contain free fatty acids rather than triglycerides predominately found in nature. Thus, we conducted the current study to examine whether CLA infused as a triglyceride would depress milk fat and enrich milk with CLA similarly to CLA as free fatty acids. Lactating Holstein cows ($n = 4$) were used in a cross over design. Periods lasted 6 d with 2 d of baseline followed by 4 d of CLA infusion in which 50 g/d of CLA (CLA-60, Natural Lipids, Norway) was delivered in a free fatty acid or triglyceride form. The CLA mixture contained (as a percentage of CLA isomers) *cis*-9, *trans*-11 (23.7%), *trans*-10, *cis*-12 (34.5%) and other CLAs (41.8%). Lipid was homogenized with skim milk and infused directly into the abomasum. Seven d wash out existed between periods. No changes in feed intake, milk yield, or milk protein percentage were detected ($P > 0.05$) during CLA infusions. Milk fat content was decreased ($P < 0.05$) from 4.14 to 2.37% and from 3.95 to 2.64% for cows infused with CLA as free fatty acids or triglyceride, respectively. No effect of CLA form was detected. For both lipid types, reductions in milk fat percentage appear to be a result of decreased ($P < 0.05$) de novo fatty acid synthesis, specifically C6:0 (35.1%), C8:0 (36.6%), C10:0 (39.1%), C12:0 (33.5%) and C14:0 (16.3%). Milk fat CLA isomer concentrations increased ($P < 0.05$) from 0.67 to 1.16% for *cis*-9 *trans*-11 and from non-detectable levels (less than 0.01%) to 0.32% for *trans*-10 *cis*-12, with no detectable difference between treatments for either isomer. Commercial mixtures of CLA are potent inhibitors of milk fat synthesis and enhance milk CLA concentrations when infused abomasally in either the form of free fatty acids or triglycerides.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression

693 Effect of dose of calcium salts of conjugated linoleic acid (CLA) on milk yield, fat and CLA content of milk fat in Holstein cows early in lactation. J.G. Giesy*¹, T.W. Hanson¹, H.C. Haflinger¹, M.A. McGuire¹, C.H. Skarie², and K. Cummings³, ¹University of Idaho, Moscow, ²Conlinco, Detroit Lakes, MN, ³Church & Dwight Co. Inc., Princeton, NJ.

Previous research in our laboratory demonstrated milk fat depression in early and mid lactation cows fed calcium salts of CLA isomers while enhancing CLA content of milk fat. Reduced milk fat synthesis occurred when cows were fed 50 g CLA-60 (Conlinco) as a topdress supplement. Objective of the current study was to evaluate a dose response of CLA feeding on milk fat percentage. Five multiparous Holstein cows averaging 93 ± 5 d in milk and 46.5 ± 3.0 kg/d milk yield were used in a 5 x 5 Latin square design. Each period consisted of 5 d treatment phase followed by 9 d rest. Cows received injection of bST 3 d prior to initial treatment of each period. Treatments consisted of 0, 10, 25, 50 or 100 g CLA from CLA-60 in calcium salt form (Church & Dwight). The CLA-60 mixture contained (as a percentage of CLA isomers) *c9*, *t11* (23.7%), *t10*, *c12* (34.5%) and other CLAs (41.8%). Supplements were made isolipid with addition of Megalac[®] and were fed once daily (0700 h) as a topdress. After consuming supplement, cows were fed a TMR containing 19% CP, 20% ADF, 39.8% NFC and 5% lipid. Milk was sampled at each milking and analyzed for components and fatty acid profile. Mean dry matter intake (25.8 ± 0.3 kg/d) and milk yield (43.5 ± 0.4 kg/d) were not affected ($P > 0.05$) by dose of CLA. On d 5 of supplementation, milk fat percentage decreased linearly ($P < 0.05$) with increasing dose of CLA (3.08, 2.85, 2.83, 2.46 and 2.29% for 0, 10, 25, 50 or 100 g CLA, respectively). Milk fat depression was associated with a linear ($P < 0.01$) reduction in C6:0, 8:0, 10:0 and 12:0 fatty acids. Milk fat content of *c9*, *t11* and *t10*, *c12* isomers of CLA increased linearly (4.9 to 6.4 mg/g fat; $P < 0.01$) and quadratically (0.3 to 1.3 mg/g fat; $P < 0.05$), respectively, with increasing dose. Linear effect of dose on milk fat and quadratic effect of dose on *t10*, *c12* CLA suggest maximal milk fat depression was not achieved by feeding 100 g (21.1g *t10*, *c12*) of CLA.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression

694 Response of milk fat to intravenous administration of the trans-10, cis-12 isomer of conjugated linoleic acid (CLA). S. Viswanadha*, T. W. Hanson, J. G. Giesy, and M. A. McGuire, University of Idaho, Moscow.

Abomasal infusion of commercial mixtures of CLA has been shown to decrease milk fat synthesis. Ten g/d of the *trans*-10, *cis*-12 isomer of CLA has been shown to cause milk fat depression when infused abomasally. Our objective was to determine the dose dependent response to intravenous administration of the *trans*-10, *cis*-12 isomer of CLA. Four multiparous Holstein cows averaging 123 ± 30 DIM were randomly assigned to treatments in a 4 x 4 Latin square design. Catheters were inserted into the jugular vein for infusions and blood sampling. Treatments consisted of intravenous infusions of 0, 2, 4 and 6 g/d CLA (>95% *trans*-10, *cis*-12 CLA, Natural Lipids, Norway). Infusates contained 72 g/d 10 % Intralipid (Baxter; Deerfield, IL), saline and CLA to 90 ml. They were divided into six equal parts and infused every 4 h. Periods were of 5 d duration with a 7 d wash out. Milk samples were obtained twice daily and analyzed for fat, protein and CLA. Dry matter intake (23 ± 2.4 kg/d), milk yield (29.5 ± 3.3 kg/d) and protein percent ($3.26 \pm 0.084\%$) were not affected ($P > 0.05$) by treatment. However, milk fat percent was reduced ($P < 0.05$) and the response was linear to the dose of CLA infused. Milk fat percent was 4.02, 3.86, 3.29 and 2.92% on d 5 for treatments 0, 2, 4 and 6 g/d CLA. Concentrations of *cis*-9, *trans*-11 (3.66 mg/g fat) and *trans*-10, *cis*-12 CLA in milk fat were not affected by treatment. Milk fat contained 0.86, 0.95, 0.93 and 2.03 mg of *trans*-10, *cis*-12 CLA per gram of fat (SE=0.065) for treatments 0, 2, 4 and 6 g/d CLA respectively. Efficiency of incorporation of *trans*-10, *cis*-12 isomer of CLA into milk fat was calculated to be 28.5% for the 6 g/d treatment. Intravenous infusion of the *trans*-10, *cis*-12 isomer of CLA depressed milk fat in a linear manner over the range of infusion studied. However, concentration of CLA in milk fat was unaffected by treatment.

Key Words: Conjugated linoleic acid, Milk fat, Trans-10, cis-12 CLA

695 The role of Δ^9 -desaturase in the production of *cis*-9, *trans*-11 CLA and other Δ^9 desaturated fatty acids in milk fat. B. A. Corl*¹, L. H. Baumgard¹, D. A. Dwyer¹, J. M. Grünari², B. S. Phillips³, and D. E. Bauman¹, ¹Cornell Univ., Ithaca, NY, ²Helsinki Univ., Finland, ³NCAUR, ARS/USDA, Peoria, IL.

Biomedical studies with animal models have shown *cis*-9, *trans*-11 conjugated linoleic acid (CLA), the predominant isomer in milk fat, has anticarcinogenic effects. We recently demonstrated that a portion of milk fat CLA originates by endogenous synthesis from *trans*-11 C_{18:1} by Δ^9 -desaturase (Corl et al., J. Anim. Sci. 77 (Suppl. 1):118). Our present objective was to examine the contribution of endogenous synthesis of CLA by inhibiting Δ^9 -desaturase with sterculiol oil (SO) and by increasing exogenous supply of substrate with addition of partially hydrogenated vegetable oil (PHVO). In a 4 x 4 Latin square design with lactating dairy cows (115 ± 9 DIM, mean ± s.d.), treatments were 1) control (C), 2) SO (10 g/d), 3) PHVO (250 g/d) and 4) SO+PHVO. Treatment periods were 4 d and both SO, prepared as an emulsion in skim milk, and PHVO were abomasally infused (4x/d). Treatments had no effect on milk yield (38.7 kg/d), milk protein yield (1.07 kg/d) or DMI (26.4 kg/d), but milk fat yield was decreased 14.3% by SO and PHVO treatments. As expected, milk fatty acid composition was altered. The PHVO treatment increased milk fat concentration of *trans*-11 C_{18:1} (39.0%) and CLA (17.3%) compared to C. Addition of sterculiol oil caused the opposite result; CLA was reduced by 65.3% for the SO vs C treatments and by 61.1% for the SO+PHVO vs PHVO treatments; this represents a minimal estimate of the endogenous contribution. The inhibition of Δ^9 -desaturase was incomplete and using a correction factor derived from C_{14:1} indicated a maximum of 78% of the milk fat CLA was of endogenous origin. Overall, data clearly demonstrate that the majority of CLA in milk fat arises from endogenous synthesis via Δ^9 -desaturase. Data also indicate that Δ^9 -desaturase is involved in the formation of other milk fatty acids including *cis*-monoene saturated fatty acids (C_{14:0}, C_{16:0}, C_{18:0}) and conjugated and non-conjugated dienes from *trans* isomers of C_{18:1}.

Key Words: milk fatty acids, desaturase

696 Effects of duodenal infusion of graded amounts of Leu on mammary uptake and metabolism in dairy cows. H. Rulquin*¹ and P.M. Pisulewski², ¹UMRPL INRA, St Gilles, France, ²Agricultural Univ., Cracow, Poland.

Leu is one of the proposed limiting amino acids for dairy cow. However, its requirement and the dynamic of its metabolism in the mammary gland are poorly documented. A 4x4 Latin square was realized to study effects of duodenal infusion of graded amounts of Leu (0, 40, 80, and 120 g/d) during 4 days on mammary uptake and milk secretion in Holstein cows. Diet covered 100 and 75% of energy and protein requirements. An extra duodenal infusion of 430 g/d of free Leu mixture of Met, Lys, Thr, Phe, Val, Ile, His, Arg, Tyr and Glu was used to meet 110% of protein requirements. Supply of Leu provided 75, 100, 125, and 150% of the expected requirements for the 4 treatments respectively. Cows equipped with a duodenal cannula and an ultrasonic blood flow probe fitted around a pudic artery were sampled for arterial and mammary venous blood 6 times during 12 hours. Milk yield was unaffected by infusions. Milk protein secretion increased significantly to a maximum between the second and the third doses (570, 652, 648, and 624 g/d). Arterial concentrations of Leu in plasma increased linearly with amounts infused (0.55, 1.40, 1.88, and 2.12 mg/100 ml). Mammary extraction rate linearly decreased (72, 47, 44, and 36%), whereas mammary uptake increased (13.7, 19.4, 26.8, and 23.4 mg/min for a half udder). Uptake of other essential amino acids followed that of Leu. Ratio of Leu plasma uptake to milk output increased to a maximum for the third dose (1.05, 1.31, 1.87, and 1.66). It was concluded that 1) mammary uptake of Leu is closely related to arterial level, 2) maximum mammary protein synthesis is achieved when the uptake of Leu is 1.31 times the Leu milk output, 3) optimum of dietary Leu concentration is located between 8.87 and 11.1% of Leu truly digested in the small intestine (LeuDI) in proteins truly digested in the small intestine (PDI).

Key Words: Leu, Mammary metabolism, Dairy cow

697 Effects of duodenal infusion of graded amounts of His on mammary uptake and metabolism in dairy cows. H. Rulquin*¹ and P.M. Pisulewski², ¹UMRPL INRA, St Gilles, France, ²Agricultural Univ., Cracow, Poland.

Histidine is proposed as the third limiting amino acid for dairy cows after Met and Lys. However, its requirement and the dynamic of its metabolism in the mammary gland are poorly documented. A 4x4 Latin square was used to study effects of duodenal infusion of graded amounts of L-His-HCl-H₂O (0, 36, 55, and 74 g/d) during 4 days on mammary uptake and milk secretion in Holstein cows. Diet covered 100 and 75% of energy and protein requirements respectively. An extra duodenal infusion of 430 g/d of free His mixture of Met, Lys, Thr, Leu, Trp, Val, Ile, Phe, Arg, Tyr and Glu was used to meet 110% of protein requirements. Supply of His provided 75, 100, 125, and 150% of the expected requirements for the 4 treatments respectively. Cows equipped with a duodenal cannula and an ultrasonic blood flow probe fitted around a pudic artery were sampled for arterial (carotid) and venous blood (subcutaneous) 6 times during 12 hours. Milk yield was unaffected by infusions, but protein yield increased linearly (610, 675, 694, and 720 g/d). True protein concentration of milk increased significantly to a plateau at the second dose infused (2.80, 3.07, 2.97, and 3.03%). Arterial concentrations of His in plasma increased linearly (0.17, 1.27, 1.25, and 1.50 mg/100 ml). Mammary extraction rate decreased dramatically to a minimum at the second dose infused (55, 16, 15, and 15%) whereas mammary uptakes increased linearly (5.51, 11.64, 11.88, and 14.03 mg/min for a half udder). Ratio of plasma uptake of His to milk increased linearly (0.90, 1.12, 1.18, and 1.24). Mammary flow of plasma decreased linearly (7.19, 4.93, 4.69, and 4.77 L/min for a half udder). It is concluded that 1) mammary uptakes of His is related to arterial level of His, 2) optimum milk protein yield is obtained when mammary uptake is 1.2 times the milk output, 3) optimum of dietary His concentration is located between 3.4 and 5.6% of His truly digested in the small intestine (HisDI) in proteins truly digested in the small intestine (PDI).

Key Words: His, Mammary metabolism, Dairy cow

698 Compensatory nutrition regulation of β -casein gene expression in HC11 mammary epithelial cells. J.W. Schroeder*, W.K. Keller, and C.S. Park, North Dakota State University, Fargo.

Energy restriction and realimentation imposed during developmental stages enhances mammary growth and differentiation. Objectives were to develop an understanding of cellular mechanisms that modulate proliferation and differentiation in HC11 murine mammary epithelial cells in culture. In two separate studies, cells were seeded and grown in a humidified environment at 37°C and 5% CO₂, until confluent, in medium consisting of RPMI-1640 with L-glutamine, 10% fetal bovine serum, 5 μ g/mL insulin, 10 ng/mL epidermal growth factor and 50 μ g/mL gentamicin. Cells were then preincubated for 24 h, but without epidermal growth factor. The subsequent induction medium was growth medium without epidermal growth factor, plus 0.1 μ M dexamethasone and 5 μ g/mL prolactin. Control medium contained 2 mg/mL glucose, treatment medium contained 0.5 mg/mL glucose, and realimentation medium contained 3 mg/mL glucose. In Study One, glucose was restricted during the induction phase. Cell proliferation of treatment cells was reduced 32% following energy restriction, while treatment cells had 33% greater proliferation than that of the control following refeeding. Protein synthesis was not different for the treatment cells after restriction, but was 6.5% greater following realimentation. Protein secretion levels were greater for the control after 96 h. Gene expression of β -casein and poly(ADP-ribose) polymerase was not affected by glucose level during cell induction. In Study Two, glucose levels were modified during logarithmic growth. Treatment group cell proliferation tended to be higher than that of the control at the onset, but the means were not different. Protein synthesis tended to be higher in treated cells than in control cells, but protein secretion levels were not different. Transcript levels of poly(ADP-ribose) polymerase, γ -glutamyl transpeptidase, and xanthine oxidoreductase were different at 48 h of induction only; ornithine decarboxylase displayed similar trends in gene expression, but levels were not different. Results indicate that energy restriction and realimentation during the induction phase altered cell proliferation and protein synthesis. When energy modulation was employed during rapid cell growth, subsequent alteration in cell proliferation and protein synthesis and secretion were more subtle.

Key Words: HC11 cell line, Proliferation, Differentiation, Compensatory nutrition

699 Linoleic acid upregulates expression of mFABP and CD36 in bovine mammary cells. R.C. Gorewit*¹, ¹Cornell University, Ithaca, NY.

Fatty acid binding proteins (FABPs) are involved in fatty acid metabolism, and growth and differentiation of a variety of tissues. CD36 is a glycoprotein cell adhesion molecule (CAM) thought to be involved in the proliferation and differentiation of a variety of cells. It is in very high concentrations in milk fat from lactating cows. Expression of FABP and CD 36 are upregulated by certain fatty acids, termed peroxisome proliferators in liver and adipose tissues. The purpose of our study was to determine if linoleic acid would up regulate the expression of mFABP and CD36 in cultured bovine mammary cells. Bovine mammary cells, isolated from lactating cows and cloned as epithelial cells by micromanipulation, were used. They were grown to confluency in Dulbecco's modified Eagles medium containing 10% horse serum. After confluency, cells were exposed to the following: 20ul of 40 % ethanol- 60% medium, linoleic acid 20 ul (400nM). Dishes were incubated for 12 hrs. After incubation, cells were washed with medium, and collected using a rubber policeman, centrifuged in a microcentrifuge and solubilized in Triton X-100, buffered at pH 7.4, and subjected to SDS- PAGE electrophoresis and Western immunoblotting. Total mRNA was isolated from cells for Northern blot analysis. An increase in FABP and CD36 protein and mRNA expression were seen from cells incubated with linoleic acid compared to controls. These data indicate that linoleic acid upregulates expression of mFABP and CD36, two factors that are involved in growth and differentiation of mammary cells.

Key Words: Linoleic acid, FABP, CD36

700 Immunoreactive BRCA1 is localized in bovine mammary epithelium, milk and milk fat globule membranes. Y Chung¹, V.L. Spitsberg², and R. C. Gorewit*¹, ¹Cornell University, Ithaca, NY, ²BioVita Technologies.

BRCA1 is the first breast cancer susceptibility gene that has been isolated, and structural defects of the gene increase early onset breast and/or ovarian cancer. There is controversy with regard to the localization of BRCA1 within the cell and whether or not it is a secreted protein. Therefore, we determined if immunoreactive BRCA1 was secreted into human and cows milk and examined its cellular localization in bovine mammary tissue. Milk fat globule membranes were isolated from fresh bovine and human milk. Proteins were isolated by SDS PAGE, transferred to nitrocellulose membranes and incubated with mouse monoclonal anti-BRCA1 antibody and subsequently incubated with secondary antibody. For immunolocalization, mammary tissues from lactating and involuting cows were fixed and paraffin embedded. Eight micron serial sections were prepared. Slides were deparaffinized and incubated with human specific anti-BRCA1 antibodies. Immunoreactive BRCA1 was detected in MFGM from human and cow milk. The size of bovine BRCA1, was identical to the human. It was a full length 220 kDa protein. Immunohistochemistry showed the protein localized in the nucleus, cytosol, milk and milk fat globule membrane. Staining was specific for epithelial cells. These results strongly suggest that BRCA1 is secreted into milk as a component of the MFGM and is located specifically in the mammary epithelial cell.

Key Words: BRCA1, Epithelial cells, MFGM

701 Bovine mammary BRCA1 is differentially expressed through various physiological stages. Y Chung¹ and R.C. Gorewit*¹, ¹Cornell University, Ithaca, NY.

BRCA1 is necessary for the growth of various tissues and appears to be involved in tumor suppression. The ability of the BRCA1 C-terminus domain to stimulate p21 provides direct evidence of its role as a transcriptional activating factor. Cross talking with other proteins, such as Rad51 and BARD1 implies that it takes part in DNA repair during the S-phase. The role of BRCA1 in normal mammary development is not clear. We examined BRCA1 gene expression in bovine mammary tissues from heifers during pregnancy and cows in early, mid and late lactation and involution. Mammary tissue biopsies were collected and immediately frozen in liquid nitrogen for total RNA isolation. Total RNAs were isolated by Tri reagent and assayed for expression by RNase Protection Assay (RPA). BRCA1 transcript expression increased during pregnancy and reached its peak during terminal mammary differentiation in late pregnancy. In cows, levels of expression increased as lactation advanced

and the levels remained high until mid-lactation. The expression levels dramatically decreased in late lactation and remained low during involution. Our data suggests that BRCA1 is differentially expressed during pregnancy and lactation in cattle and that the protein is likely involved in normal bovine mammary growth and differentiation.

Key Words: BRCA1, Lactation, Pregnancy, Involution, mRNA

702 Lipid synthesis by primary cultures of bovine mammary epithelial cells. E. Matitashvili*¹ and D. Bauman¹, ¹Cornell University, Ithaca, NY.

Lipid synthesis by primary mammary epithelial cells isolated from lactating cows was studied in different culture conditions. The cells were cultured in serum-free medium containing insulin, prolactin and hydrocortisone using attached or floating calf tail collagen, or complex of extracellular matrix proteins (ECM) isolated from lactating bovine mammary gland. The rate of lipid synthesis assessed by ¹⁴C-acetate incorporation had approximate ratio 1: 1.7 : 2 for cells cultured on attached collagen : floating collagen : ECM. Overall, the degree of cellular differentiation had a major impact on the percent of secreted lipids, on the distribution of labeled acetate among different lipid classes and on the level of expression of mRNA for acetyl-CoA carboxylase, glycerol phosphate acyltransferase, acylglycerol phosphate acyltransferase, stearoyl-CoA desaturase and fatty acid-binding protein. The percent of secreted lipids ranged from 22 to 64%, being lowest for cells cultured on attached collagen gels. Thin layer chromatography showed that triglycerides were predominant lipid class in cells cultured on all substrata but their proportion increased from 59 to 79% in more differentiated cells. The rate of ¹⁴C acetate incorporation in cells cultured on floating collagen gels was stable for 5 days, although percent of secreted lipids decreased slightly at the end of culture. The expression of all above mentioned proteins was higher in more differentiated cells and was stable for at least 6 days in cells cultured on floating collagen gels and on ECM.

Key Words: Mammary, Culture, Lipid

703 Effect of different isomers of C18:1 and C18:2 fatty acids on lipogenesis in bovine mammary epithelial cells.. E. Matitashvili*¹ and D. Bauman¹, ¹Cornell University, Ithaca, NY.

Primary bovine mammary epithelial cells isolated from an early lactating cow were plated on collagen gels and incubated in medium containing 10 % fetal bovine serum for 24 h. The cells were cultured in serum-free and fatty acid-free medium for another 24 h. Treatments were then added with a fresh portion of the same medium. Treatments consisted of C18:1,c9; C18:1,c11; C18:1,t11; C18:2,c9t11; C18:2,t10c12 fatty acid isomers (200 μ M) complexed to BSA (3:1). Treatments continued for either 6 h or for 72 h. C18:2,t10c12 inhibited ¹⁴C-acetate incorporation into cellular lipids by about 60 % mimicking the inhibition of milk fat synthesis seen in dairy cows abomasally infused with this isomer. Some of the key enzymes involved in milk lipid synthesis: acetyl-CoA carboxylase (ACC), glycerol phosphate acyltransferase (GPAT) and acylglycerol phosphate acyltransferase (AGPAT) were not greatly affected by any of the treatments including C18:2,t10c12. Therefore, it seems likely that fatty acid synthetase (FAS) could be the major site of alterations in the biochemical pathway of milk lipid synthesis in the cells treated with this isomer, although it remains to be confirmed. C18:1,t11 stimulated expression of mRNA for stearoyl-CoA desaturase (SCD) almost three-fold. This could potentially lead to increased synthesis of C18:2,c9t11 in treated cells. Surprisingly, C18:1,c11 had no effect on SCD expression. None of the treatments altered expression of the κ -casein gene.

Key Words: Fatty acid, Mammary, Culture

704 Effects of insulin and insulin-like growth factor (IGF)-I on casein and IGF-binding protein production in primary cultures of bovine mammary cells. M. D. Hanigan*¹, F. Cheli², J. C. Chow¹, W. Y. Kim¹, D. M. Carlson¹, C. C. Calvert¹, and R. L. Baldwin¹, ¹University of California, Davis, ²University of Milan, Italy.

Insulin and IGF-I have been observed to stimulate milk protein synthesis. They also stimulate mammary blood flow thereby delivering more metabolites to the udder. It is possible that these endocrine effects

are mediated entirely by changes in substrate supply. The objective of this work was to test whether these endocrines would stimulate α -casein secretion rates in the absence of a change in metabolite supply. Two experiments were conducted, one with tissue slices taken from 2 lactating cows and the second using isolated alveoli derived from 4 lactating cows. When plated on rat-tail collagen gels, these cells secreted α -casein into media (ELISA) for a minimum of 17 d. There were no detectable differences in ^3H -proline incorporation into total protein when tissue slices were exposed for 2 h to 5 ng insulin/ml, 5 ng insulin plus 50 ng IGF-I/ml, or 1 μg insulin/ml. In the 2nd experiment, there were no detectable differences in α -casein secretion among treatments when confluent cells were treated for 2 d with 1 ng insulin/ml (LI), 1 ng insulin plus 200 ng insulin-like growth factor-I/ml (IGF), or 1 μg insulin/ml (HI). α -Casein secretion was not found to be correlated with DNA mass. No significant differences in DNA mass per well were observed. The IGF treatment resulted in significantly greater ^3H -proline incorporation into secretory protein as compared to HI ($P=.06$) but not as compared to LI. Production of insulin-like growth factor binding protein (IGFBP)-2 and the 40K form of IGFBP-3 (ligand blot assay) was significantly enhanced by IGF ($P=.07$) as compared to HI but not LI. Production of IGFBP-2 was significantly enhanced by HI as compared to LI ($P=.10$). Insulin and IGF-I appear to play a role in regulating IGFBP production and total secretory protein synthesis in mammary tissue. There were no detectable effects on rates of α -casein secretion.

	LI	IGF	HI	SE
α -casein ($\mu\text{g}/\text{well}/\text{d}$)	.79	1.13	1.03	.21
^3H -Proline (cpm/well/d)	4881 ^{x,y}	6736 ^x	3397 ^y	1307
DNA ($\mu\text{g}/\text{well}$)	2.26	1.39	1.69	.74
IGFBP-2 ^b	.19 ^x	.30 ^{x,y}	.41 ^y	.11
IGFBP-3 (40K) ^b	.021 ^{x,y}	.034 ^x	.016 ^y	.008
IGFBP-3 (43K) ^b	.077	.061	.069	.038

^a LSM ^b Scanning densitometry units ^{x,y}Means in the same row with different superscripts differ ($P<.10$)

Key Words: Milk Protein, Insulin, Insulin-like Growth Factor-I

705 An ultrasonographic method for estimating mammary cistern volume after different milking intervals in dairy cows. M. Ayadi¹, G. Caja^{*1}, X. Such¹, and C.H. Knight², ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Hannah Research Institute, Ayr, UK.

Four lactating Holstein cows (3 multiparous and 1 primiparous; average milk yield: 20 \pm 3 l/d) were used to define a methodology for the estimation of the area of udder cisterns (*Sinus lactiferi*) by B-mode real time ultrasonography and to study the evolution of milk stored in the gland at different milking intervals. A sectorial transducer probe (5MHz, 80° scanning angle) placed in close parallel to the teats and towards the udder was used to obtain vertical cut pictures in two perpendicular planes (A, 0°; and B, 90°). Udder scans A and B in duplicate for each udder quarter were taken randomly at 4, 8, 12, 16, 20 and 24h intervals. After scans, cisternal milk was evacuated by using a teat cannula after the injection of an oxytocin receptor blocking agent (10mg/kgBW Atosiban®). Alveolar milk from each quarter was obtained by machine milking using oxytocin. Scans were analyzed using specialized software. Glandular parenchyma (echogenic) and lumen full of milk of the cisterns (anechoic) were in evidence in the scans. Measured areas (3423 to 42274 pixels) and evacuated milk (0.09 to 2.14 l) in the cistern of each quarter increased in parallel with time showing a curvilinear evolution with saturation after 16h. No differences were observed between A and B scans which were highly correlated ($r=0.92$, $P<0.01$) and were, therefore, averaged for each quarter. Correlation between cisternal milk and area showed the highest values in the 8 to 12 h milking interval ($r=0.84$ to 0.88; $P<0.01$) as a consequence of milk storage pattern. Alveolar milk (0.62 to 3.26 l) increased rapidly between 4 and 16 h and thereafter was steadily constant. We conclude that, the proposed ultrasonographic methodology gives a satisfactory estimation of cisternal milk between 8 and 12 h after milking and it can be used as a non-invasive method in the dynamic studies of dairy cow mammary glands.

Key Words: Ultrasonography, Cisternal Milk, Udder

706 Interbreed differences in cisternal and alveolar milk partitioning in the udder according to yield in dairy sheep. M. Rovai¹, X. Such¹, G. Caja^{*1}, and C.H. Knight², ¹Universitat Autònoma de Barcelona, Bellaterra, Spain, ²Hannah Research Institute, Ayr, UK.

With the aim of studying the interbreed differences in machine milkability, a sample of 10 Manchega (MN, 0.93 l/d) and 10 Lacaune (LC, 1.87 l/d) ewes were used to compare the milk partitioning in the udder at mid lactation (90 DIM). Milk fractions and cisternal area were measured in the milking parlor at the p.m. milking, with (ATO) or without (CON) a previous i.v. injection of an oxytocin receptor blocking agent (Atosiban®; 10 $\mu\text{g}/\text{kgBW}$) when animals were in the stalls, to evaluate the spontaneous milk ejection reflex. Cisternal area was estimated by ultrasonography using a sectorial transducer (5MHz, 80°). Cisternal milk was drained by using a teat cannula. Finally, alveolar milk was machine milked after an i.v. injection of extra oxytocin (4IU) in order to empty the udder. According to differences in daily milk yield, both groups differed ($P<0.001$) in cisternal milk (LC, 269ml; MN, 120ml) and cisternal size (LC, 24cm²; MN, 13cm²) but not in alveolar milk (LC, 102ml; Mn, 95ml; $P>0.05$). Correlation of estimated areas in the scans and cisternal milk was $r=0.79$ (MN, 0.82; LC, 0.50). Atosiban showed differences in milk partitioning depending on the breed. Cisternal values were similar in MN ewes (CON, 12.4cm² and 122ml; ATO, 13.1cm² and 118ml; $P>0.05$), but differed in LC (CON, 24.0cm² and 299ml; ATO, 23.3cm² and 239ml; $P<0.01$), for area and drained milk, respectively. Consequently, alveolar milk was similar in MN ewes (CON, 86ml; ATO, 104ml; $P>0.05$) and different in LC (CON, 89ml; ATO, 115ml; $P<0.001$). We conclude that milk partitioning can be done in MN ewes without the use of a blocking agent, but not in LC ewes, which showed spontaneous milk ejection in the milking parlor. Despite the differences in milk yield, alveolar milk was the same in both breeds, indicating the main role of the cisterns in milk secretion of dairy sheep. Values of milk partitioning were in accordance to the known milkability of each breed, the LC giving higher machine milking fraction.

Key Words: Dairy Ewes, Oxytocin, Milk Ejection

707 Postweaning changes in the porcine mammary gland parenchymal wet weight. J.A. Ford, Jr.*¹, S.W. Kim, and W.L. Hurley, University of Illinois, Urbana.

The objectives were to characterize the change in parenchymal wet weight of mammary tissue in sows which occurs following weaning and to determine the effects of administration of estrogen on postweaning mammary gland regression. Forty-five primiparous sows were used in this study. Litter size was set to 10 piglets on d 1 of lactation by cross-fostering. Estrogen vehicle or estrogen vehicle plus estrogen (.25 mg / kg BW / day) was administered to sows twice daily in equal doses beginning at the time of weaning on d 21 of lactation and continuing until slaughter of the sow. Sows were slaughtered on d 0 (d 21 of lactation), 2, 3, 4, 5, or 7 of involution. Functional and nonsuckled teats were identified before mammary glands were collected at slaughter. Mammary glands were trimmed of skin and extraneous fat pad, and each gland was individually weighed. Only glands which had been suckled throughout lactation were included in this analysis. Mammary gland wet weight decreased ($P < .01$) from weaning (485.7 \pm 8.2 g at d 0 of involution) through 7 d postweaning (159.6 \pm 9.5 g at d 7 of involution). Rate of decline in mammary wet weight for the 7 d postweaning period was 50.5 \pm 1.9 g / d for the nonestrogen treated sows ($P < .0001$) and 45.9 \pm 1.9 g / d for estrogen treated sows ($P < .0001$). Decline in mammary wet weight during involution was slower for estrogen-treated sows compared with nonestrogen treated sows ($P < .02$). The major difference between mammary wet weights of suckled glands of estrogen-treated (397.5 \pm 13.2 g) vs. nonestrogen-treated sows (316.5 \pm 12.8 g) was observed at d 2 of involution ($P < .01$). Mammary parenchymal wet weight decreases by about two-thirds during the initial 7 d postweaning. The rate of regression is decreased by treatment with estrogen, particularly in the period from weaning to d 2 of involution. Mammary involution in sows after weaning is an important part of the normal cycle of mammary growth, lactation and regression.

Key Words: Sow, Mammary Gland, Involution

708 Milk composition in early lactation is affected by expression of a bovine α -lactalbumin transgene in sows. M. S. Noble*, G. T. Bleck, J. B. Cook, M. B. Wheeler, and W. L. Hurley, *Department of Animal Sciences, University of Illinois, Urbana.*

The objective was to determine the effect of bovine α -lactalbumin (α -LA) in transgenic sows on milk composition in early lactation. Colostrum and milk samples were collected from first parity α -LA transgenic sows ($n = 8$; transgenic) and their non-transgenic full-sibling littermates ($n = 10$; control). Colostrum and milk samples were analyzed for concentrations of lactose, total solids, protein and fat. Lactose concentration was greater ($P = 0.05$) in milk of transgenic sows during the first week of lactation, when compared with milk from control sows. Lactose concentration was not different between transgenic and control sows after d 7 postpartum. Total solids, protein and fat concentrations of colostrum from transgenic sows were present at lower concentrations ($P < 0.1$) as compared with colostrum from control sows. By 48 hours postpartum, total solids, protein and fat concentrations were no longer different in milk of transgenic and control sows. Increased expression of α -LA in the peripartum period of transgenic sows may result in increased lactose concentration and decreased concentration of the other major components of colostrum and milk during early lactation. Although lactose is the major osmole in milk, other osmoles also contribute to the osmotic balance, particularly in colostrum which has a high protein concentration. Increased synthesis of lactose in the peripartum period may increase the contribution of lactose to the osmotic balance of colostrum. This in turn may lead to greater water content of colostrum, resulting in dilution of other colostrum solids. Expression of the α -LA transgene in first parity sows has a significant impact on milk composition early in lactation.

Key Words: milk composition, transgenic, swine

709 Milk fatty acid composition and mammary lipid metabolism in Holstein cows fed protected or unprotected canola seeds. C. E. Ahnadi¹, L. Delbecchi*¹, J. J. Kennelly², and P. Lacasse¹, ¹*Dairy and Swine R&D Center, Lennoxville, QC, Canada*, ²*University of Alberta, Edmonton, AB, Canada.*

Six Holstein cows in mid-lactation were fed a total mix ration supplemented with either 6% canola meal (control), or 4.5% unprotected canola seeds plus 1.5% canola meal (UCS), or 6% formaldehyde-protected canola seeds (PCS). The control, UCS, and PCS supplements contained respectively 6.7%, 45.4%, and 25.5% of lipid, mainly composed (60%) of C18:1. Treatments were applied according to a double 3X3 Latin square design with 3-week periods. Blood and milk samples and mammary biopsies were harvested during the last week of each period. Feeding UCS and PCS supplements slightly decreased ($P < 0.05$) milk production, milk protein content, and milk protein yield, without affecting milk fat content and yield ($P > 0.1$). Blood concentrations of C18:0 and C18:1t11 were increased by UCS ($P < 0.05$) but not by PCS ($P > 0.25$), suggesting that formaldehyde protection against ruminal biohydrogenation was efficient. Feeding canola seeds increased C18:1c9 in blood ($P < 0.01$) and this increase was greater with PCS ($P < 0.05$). NEFA content in serum was significantly affected by the type of supplement used, with values of 71.4 μ Eq/l, 77.4 μ Eq/l, and 85.0 μ Eq/l for control, UCS, and PCS, respectively ($P < 0.05$). UCS and PCS treatments decreased the proportion in milk fat of short chain fatty acids ($P < 0.01$) and increased that of C18:1c9 ($P < 0.01$) which averaged 22.7%, 26.6% and 27.6% for control, UCS and PCS, respectively. UCS enriched milk fat in C18:0 ($P < 0.05$) which averaged 13.4%, 15.4% and 13.7% for control, UCS and PCS, respectively. Accordingly, a higher C18:1c9 : C18:0 ratio was observed in milk fat during PCS feeding ($P < 0.01$). PCS resulted in a higher milk fat content of polyunsaturated fatty acids ($P < 0.01$). Analysis of acetyl-CoA carboxylase (ACC) gene expression in the mammary gland using semi-quantitative RT-PCR showed a higher ACC expression ($P < 0.05$) with PCS than with UCS. RT-PCR analysis of delta-9 stearoyl-CoA desaturase (SCD) expression showed that PCS induced significantly ($P < 0.05$) higher levels of SCD expression than control. This enhanced SCD expression, together with the dietary effect of the supplement itself, could explain the higher C18:1c9 : C18:0 ratio obtained with PCS. Project supported by Dairy Farmers of Canada.

Key Words: Milk fat, Lipogenic enzymes, Canola

710 Influence of conjugated linoleic acid (CLA) enriched cheese on body composition. T. R. Dhiman*¹, I. S. MacQueen¹, D. J. McMahon¹, J. L. Walters¹, and M. W. Pariza², ¹*Utah State University, Logan*, ²*University of Wisconsin, Madison.*

A study was conducted to determine the influence of feeding CLA enriched cheese on body composition. Thirty-six four week old ICR female mice in four treatments (9 mice per treatment) were fed diets containing either low CLA cheese, medium CLA cheese, high CLA cheese, or low CLA cheese plus synthetic CLA (synthetic CLA contained: 41% *cis*-9,*trans*-11 isomer and 44% *trans*-10,*cis*-12 isomer). The CLA contents of the diets were 0.12, 0.33, 0.53, and 0.53% of total fat in low, medium, high and synthetic CLA treatments, respectively. Low, medium and high CLA cheese were prepared from milk of cows fed diets containing forage and grain in 50:50 ratio, grass hay, or grazing pasture, respectively. Experimental period was 35 days. Animals were housed in cages (3 mice/cage) and fed ad libitum. Animal weights were recorded twice a week. On day 35 of the experiment animals were sacrificed and empty carcass weights were recorded. Freeze dried carcasses were analyzed for fat, protein, ash, and fatty acid profile. Average feed intake per cage was 8.8, 9.2, 9.1, and 8.9 g/day on DM basis in low, medium, high, and synthetic CLA treatments. Weight gain during the experiment was 4.2, 7.0, 5.5, and 3.0 g in low, medium, high, and synthetic CLA treatments, respectively. The *cis*-9,*trans*-11 isomer of CLA in empty carcass was 1.1^c, 2.7^b, 3.4^a, and 1.2^c% of fat in low, medium, high and synthetic CLA treatments, respectively. The moisture, protein, fat and ash were 65.8, 17.7, 12.5, and 4.0% of empty carcass weight in high CLA treatment versus 69.4, 20.3, 5.7, and 4.6% in synthetic CLA treatment, respectively. Results suggest that feeding CLA enriched cheese did not influence the body composition in this study. However, feeding synthetic CLA to mice reduced ($P > 0.01$) body fat (by 54%) compared with mice fed naturally enriched high CLA cheese.

Key Words: CLA, Milk, Fat

711 Mammary responses to short term close arterial infusions of selected amino acid profiles and acetate. N.G. Purdie*¹, D.R. Trout², J.P. Cant², and D.P. Poppi¹, ¹*The University of Queensland, Brisbane, Queensland, Australia*, ²*University of Guelph, Ontario, Canada.*

A 10-hour arterial infusion of 300g amino acid, having the same profile as milk protein, increased protein and decreased fat contents of milk in lactating dairy cows (Cant *et al.* J.Dairy Sci. Vol. 80 suppl. 1,153). To test whether different responses would be obtained with an infusion of a microbial amino acid profile or with an additional energy supply, 6 multiparous cows were infused arterially with a control infusion of 0.9% saline (S), a microbial profile (M) and a milk protein profile (C), with or without 500g of acetate, in a 3x2 factorial design. Cows were fitted with left and right external iliac artery catheters and subcutaneous abdominal vein catheters. Arterial and venous blood samples were collected at hourly intervals during the last three hours of infusion. Blood flow in the iliac artery was not significantly ($P < 0.05$) different across treatments. Milk protein percentages were significantly higher in the amino acid treatments than on the control, 3.72(M), 3.70(C), 3.54(S). Milk yield was increased under amino acid regimes. Acetate infusions showed a significant reduction in milk yield (514 vs 558 g/h) and significant increases in protein, fat and lactose percentages. Under acetate infusions, local arterial concentrations of acetate increased by 119%, but extraction by the mammary glands only decreased from 76.4% to 71.3%, so the acetate uptake approximately doubled. The addition of acetate to the microbial profile caused increases in protein and lactose percentages while its addition to the milk protein profile had no measurable effects. There are no significant differences in the ability of the infused amino acid profiles to ameliorate milk component production or mammary uptake of milk precursors from the blood. Milk protein production was not energy-limited at a mammary level.

Key Words: Amino acid, Acetate, Arterial infusion

712 Mammary metabolism in cows fed graded supply of rumen-protected methionine (RPM) added to a methionine imbalanced diet. M.C. Thivierge^{*1}, R. Berthiaume², J.F. Bernier¹, and H. Lapierre², ¹Universite Laval, QC, Canada, ²Dairy and Swine R & D Center, QC, Canada.

To determine the effect of RPM on the efficiency of utilization of amino acids (AA) for milk protein synthesis, three 1st and three 2nd lactation cows were used in a replicated 3 x 3 Latin square with 14-d experimental periods. Addition of 0, 36, 72 g/d of RPM (Mepron[®]-M85, Degussa Hüls Inc.) to the diet resulted in an estimated ratio of methionine/essential AA at the duodenum averaging 80, 136 and 192% of the recommended ratio of 0.051. Cows were fed in 12 equal meals daily at 95% of their previous ad libitum intake (17.5 kg DMI; SE 0.08). Six hourly blood samples were collected simultaneously from the artery and the mammary vein on d 14 of each period. Mammary plasma flow was estimated using the Fick principle, using Phe and Tyr concentration in arterial and venous plasma and in milk. Milk yield (32.8 kg; SE 1.14) and mammary plasma flow (499 l/h; SE 25) were not affected by RPM (P > 0.10). Milk CP content increased in 1st lactation cows but not in 2nd lactation cows. Methionine net flux remained constant, but as arterial concentration of Met increased, Met extraction rate by the mammary gland decreased. Uptake to output ratios indicate that the net uptake of Met and His, two AA that are not extensively oxidized in the mammary gland, remained proportional to their secretion in milk. Adding RPM did not improve significantly the utilization of BCAA by the mammary gland, as for other essential AA. Globally, the udder response to Met supply was limited. The financial support of Novalait is acknowledged.

RPM; g/d:	0	36	72	SEM	¹ Lin.	Quad.
Milk CP; g/kg						
1st lact.	30.68	32.98	34.87	0.71	0.01	0.94* ²
2nd lact.	32.11	32.24	31.76			
Met net flux; mmol/h	5.97	5.27	6.42	0.26	0.25	0.15
Met arterial; µM	17.0	21.0	32.0	1.2	≤0.01	0.04
Met extraction; %	65.5	56.3	43.2	2.3	≤0.01	0.54
Met uptake:output	0.98	1.03	0.94	0.02	0.19	0.08
His uptake:output	1.09	1.19	1.14	0.06	0.57	0.42
BCAA ³ uptake:output	1.81	1.56	1.50	0.08	0.25	0.52

¹Linear & Quadratic contrasts; ²treatment*lactation interaction; ³Val + Ile + Leu

Key Words: Cows, Methionine, Rumen-protected

713 Effect of plasma insulin concentrations on milk protein yield in dairy cows. A. L'Esperance^{*1}, J.F. Bernier¹, D.E. Bauman², and P.Y. Chouinard¹, ¹Laval University, QC, Canada, ²Cornell University, Ithaca, NY.

Elevated circulating insulin (5 times normal) in combination with abomasal infusion of casein stimulates milk protein yield in dairy cows. The objective of our study was to examine the dose-response of insulin on milk protein yield using the hyperinsulinemic-euglycemic clamp technique. The experiment involved 4 rumen-fistulated cows (61 ± 24 DIM) fed for ad libitum intake. The diet was formulated to meet NRC (1989) requirements, and cows were abomasally infused with casein (500 g/d) to ensure an adequate supply of amino acids. Cows received intravenous infusion of insulin at two different rates: 0.5 (LI) and 1 µg/kg BW/h (HI) during 4 d according to a crossover design. Data were analyzed using the mixed procedure of SAS. Plasma insulin concentrations were increased 2.4 and 5.3 times over the baseline when cows received LI and HI, respectively (P < 0.01). Glucose infusion rates required to maintain euglycemia (±10% of baseline) were 1.9 times higher for cows on HI as compared with LI (P = 0.03). Milk protein content increased gradually during the insulin infusion, and this increase was of a similar magnitude for both treatments. Milk yield increased during the first 3 d of infusion in cows receiving HI, then fell in day 4. Milk protein yield followed a similar pattern. Milk yield for cows receiving LI remained constant over the 4 d of infusion and milk protein yield increased slightly. Increasing plasma insulin 5 times over normal increased milk protein yield, but this level of insulin had negative impact on milk yield when maintained more than 3 d under our experimental conditions. Project supported by Novalait Inc. and FCAR Fund.

Item	Trt	D	D	D	D	D	Tm.	Tm.	Tm. x	Tm. x
		0	1	2	3	4	Lin	Qd.	Tm.-L	Tm.-Q
Milk (kg/d)	LI	35.8	35.3	35.1	35.2	34.5	0.13	0.01	0.69	0.01
	HI	35.3	35.8	37.9	36.1	33.0				
Protein (%)	LI	3.34	3.35	3.42	3.45	3.53	<0.01	0.02	0.64	0.33
	HI	3.29	3.30	3.29	3.45	3.52				
Protein (g/d)	LI	1193	1180	1200	1214	1217	0.73	0.09	0.77	0.03
	HI	1152	1169	1235	1233	1154				

Key Words: Dairy cows, Milk protein, Insulin

714 Effect of plasma insulin concentrations on milk fatty acid profile in dairy cows. A. L'Esperance^{*1}, J.F. Bernier¹, D.E. Bauman², B.A. Corl², and P.Y. Chouinard¹, ¹Laval University, QC, Canada, ²Cornell University, Ithaca, NY.

Recent work demonstrated that insulin regulated Δ-9-desaturase gene expression in sheep adipose tissue (Ward et al., 1998). Biochim Biophys Acta, 1391:145). The Δ-9-desaturase reaction introduces a cis-double bond between carbons 9 and 10 of fatty acids. A large portion of oleic acid (cis-C18:1) secreted in milk fat is synthesized by the action of Δ-9-desaturase on stearic acid (C18:0) in bovine mammary gland. The objective of our study was to examine the dose-response of insulin on milk fatty acid profile using the hyperinsulinemic-euglycemic clamp technique. The experiment involved 4 rumen-fistulated cows (61 ± 24 DIM) fed for ad libitum intake. The diet was formulated to meet NRC (1989) requirements, and cows were abomasally infused with casein (500 g/d) to ensure an adequate supply of amino acids. Cows received intravenous infusion of insulin at two different rates: 0.5 (LI) and 1 µg/kg BW/h (HI) during 4 d according to a crossover design. Data were analyzed using the mixed procedure of SAS. Plasma insulin concentrations were increased 2.4 and 5.3 times over the baseline when cows received LI and HI, respectively (P < 0.01). Glucose infusion rates required to maintain euglycemia (±10% of baseline) were 1.9 times higher for cows on HI as compared with LI (P = 0.03). Insulin infusions increased milk fat content of short- and medium-chain fatty acids, and decreased the proportions C18:0 and cis-C18:1 in milk fat (P < 0.01). The decrease in milk fat content of C18:0 was greater when cows received HI as compared with LI (P < 0.04). Insulin infusions decreased the ratio of C18:0 to cis-C18:1, but the decrease was of a lower magnitude when cows received LI as compared with HI (P < 0.04). Insulin shifted the balance between de novo and preformed fatty acids toward de novo, and stimulated the activity of Δ-9-desaturase as evidenced by the decreased ratio of C18:0 to cis-C18:1. Project supported by Novalait, Inc. and FCAR Fund.

Key Words: Milk fatty acids, Insulin, Δ-9-desaturase

715 Feeding strategies aimed at regulating fatty acid synthesis in the dairy cow. N.S. Beswick and J.J. Kennelly^{*}, University of Alberta, Edmonton, AB, Canada.

Our objective was to identify dietary treatments capable of lowering milk fat percentage. We identified four dietary treatments for this purpose. Four multiparous animals were fed diets in a 4 x 4 latin square design. Mammary and adipose tissue biosies were collected. The diets were: control (50:50); high concentrate (75:25); 5 % fish oil; or 5 % safflower oil. We hypothesized that each of the treatments would result in a reduction in fatty acid synthesis. We did not observe changes in milk yield, or in the percentage of milk fat. However, the yield of milk fat was significantly reduced by fish oil treatment (p<0.05). There was also a trend toward milk fat yield reduction (p<0.1) caused by the high concentrate treatment. We analysed mRNA abundance of four key lipogenic enzymes acetyl-CoA carboxylase (ACC), fatty acid synthase (FAS), lipoprotein lipase (LpL) and stearyl-CoA desaturase (SCD), protein abundance for ACC and FAS, and activity for ACC and FAS in both adipose tissue and mammary gland. No significant treatment effects were observed. There were milk fatty acid compositional changes. Fish and safflower oil treatments significantly reduced the short and medium chain fatty acids. This finding demonstrates that the oils negatively affected de novo synthesis in the mammary gland. Fish oil also resulted in significant elevations in total CLA along with specific isomers. Trans fatty acids were elevated by fish oil. Milk protein was significantly reduced by the fish oil treatment. The high concentrate diet resulted in elevation of trans fatty acids. In conclusion, we demonstrated the de

novo synthesis was reduced by both the fish oil and safflower oil treatments. While there no significant changes in the lipogenic enzymes, it is possible that the changes to de novo synthesis were not large enough to be measured. Overall, the results demonstrate that there was significant potential to alter milk fat composition.

Key Words: CLA, Lipogenesis, Milk Fat Depression

716 Role of stage of lactation in the regulation of fatty acid synthesis in the dairy cow. N.S. Beswick and J.J. Kennelly*, *University of Alberta, Edmonton, AB, Canada.*

Our objective was to determine the influence of stage of lactation on fatty acid synthesis in adipose tissue and the mammary gland of the dairy cow. We examined four multiparous animals at four time points in their lactation corresponding to early (35+7d), mid (110+1d), and late lactation (270+1d), along with 30 d into the dry period. Mammary and adipose tissue biopsies were collected at each of these time points. We measured four key lipogenic enzymes: acetyl-CoA carboxylase (ACC), fatty acid synthase (FAS), lipoprotein lipase (LpL), and stearoyl-CoA desaturase (SCD). We hypothesized that the enzymes would decrease in abundance or activity in the mammary gland and would increase in adipose tissue over the course of the lactation. We analysed the mRNA abundance of LpL and SCD, and the protein abundance and activity of ACC and FAS. The mRNA abundance of LpL in the mammary gland was not significantly affected. However, in adipose tissue this value was significantly higher in the dry period than in early lactation ($p < 0.01$). With SCD, the mid lactation value for mammary gland was highest and was significantly higher than that of the dry value ($p < 0.01$). In adipose tissue, the mRNA abundance was highest in late lactation and was significantly higher than in early lactation ($p < 0.01$). Acetyl-CoA carboxylase activity was unaffected by stage of lactation in the mammary gland, but protein abundance was significantly higher in early lactation than in the dry period ($p < 0.05$). In adipose tissue, protein abundance was not significantly influenced, but was significantly higher in the late and dry period than in the early period ($p < 0.05$). Fatty acid synthase activity demonstrated no significant effect due to stage of lactation, but this was more likely a result of the very high SEM of the activity assay. Adipose protein abundance was significantly lower in early lactation than in the dry period. Milk yield and the percentage of its components were not affected by stage of lactation. However, fatty acid composition analysis revealed that de novo synthesis of fatty acids was lower during early lactation than mid and late lactation. In conclusion, we demonstrated that stage of lactation is significant in the regulation of lipogenesis in the dairy cow.

Key Words: Stage of lactation, lipogenesis

717 The effect of abomasal amino acid imbalances on milk composition in lactating dairy cattle. T.L. Weekes* and J.P. Cant, *University of Guelph, Ontario, Canada.*

Milk production responses to rumen-protected methionine and lysine supplementation of dairy rations suggest that cows often experience an amino acid imbalance. The purpose of this experiment was to define the milk composition response to an intentionally large amino acid imbalance. The experimental design consisted of a 6x6 latin square balanced for carry-over effects. Each period was five days in length. All cows were fed a diet formulated to have 8.0% crude protein and 1.6 Mcal/Kg NE_L . The six isotonic solutions infused abomasally at 8 L/d for 5 days were: 1) 3.0% saline; 2) 15% free amino acids having the profile of milk protein as a positive control; 3) positive control minus methionine; 4)

minus lysine; 5) minus histidine; 6) minus leucine, isoleucine, and valine. The amino acid infusions were calculated to provide approximately one-third of the total duodenal amino acid flow. Milk protein yield was increased from 585 g/d on the saline control to 698 g/d with infusion of the complete amino acid solution. Removal of lysine, methionine, and histidine each reduced protein yield back to control levels; branched-chain amino acid removal had no effect. Milk fat yield was increased significantly from 728 g/d on the saline control to 986 and 1048 g/d on the lysine and histidine imbalances, respectively. Likewise, milk fat percentages increased from 3.4% with saline to 4.6% with the lysine imbalance and 5.3% with the histidine imbalance. Protein:fat ratios were .58 and .50 on these two treatments relative to .84 on the control. A post-ruminal essential amino acid imbalance decreases milk protein percentage and yield and causes a pronounced increase in milk fat secretion. Histidine removal caused the greatest imbalance effect, followed by lysine then methionine. Effects on milk composition of the amino acid infusate without branched-chain amino acids were the same as those for the positive control. Branched-chain amino acids do not limit milk synthesis.

Key Words: Amino Acid Imbalance, Milk Composition

718 The effect of long-term supplementation of conjugated linoleic acid (CLA) to dairy cows grazing tropical pasture. S. R. Medeiros¹, D. E. Oliveira¹, L.J.M. Aroeira², M. A. McGuire³, D. E. Bauman⁴, and D.P.D. Lanna*¹, ¹ESALQ, São Paulo, Brazil, ²CNPGL-EMBRAPA, Minas Gerais, Brazil, ³University of Idaho, Moscow, ⁴Cornell University, Ithaca, NY.

The objective of this study was to evaluate the effects of long-term treatment with CLA on lactating cows. Twenty Zebu X Holstein cows were rotationally grazed during the summer on stargrass (*Cynodon nlenfuensis* var. *nlenfuensis*) plus 4kg/d of a high-protein supplement formulated with corn, soybean meal, wheat middlings and fishmeal to provide 110% of estimated metabolizable protein requirements. Supplement was fed from the 4th to the 9th week of lactation, twice a day, and each treatment (n=10) received either 150g/head/day of Megalac (Control) or the same amount of a Ca-protected CLA mixture (60% CLA, Church & Dwight). Below are the averages for the 4th to the 9th week of lactation. Milk production was unchanged, despite a small increase in CLA treated cows. As a result, the differences observed in yields of milk constituents are in accordance with their contents in milk. CLA decreased milk fat content by 25% and yield by 21%. This effect was observed within two days of treatment when cows were with less than 30 days in milk, which may be related to the source of substrates for fat synthesis in the mammary gland of these low producing cows. Protected CLA greatly increased protein content and yield (+13%). Because milk production was unchanged while energy secretion decrease ($P < 0.05$) these results suggest Control cows could achieve their potential energy output under the conditions of this experiment.

	Control	CLA	Probability	CV(%)
Milk Yield, kg/day	16,6	17,0	0.516	8,9
Milk Fat, %	2,80	2,11	0.001	12,1
Milk Protein, %	2,79	3,07	0.025	7,9
Milk Lactose, %	4,62	4,50	0.239	4,7
Milk Solids, %	10,87	10,43	0.138	5,8
Milk Fat, g/day	458	361	0.025	19,7
Milk Protein, g/day	457	517	0.031	11,0
Milk Lactose, g/day	795	766	0.407	9,4
Milk Total Solids, g/day	1783	1769	0.901	12,8
Log SSC	5,18	5,70	0.477	19,8
Body Condition Score	3,5	3,5	0.867	7,5

NONRUMINANT NUTRITION

719 Effects of level of phytase on ileal digestibility of calcium, phosphorus, crude protein, and amino acids in dehulled soybean meal. S.L. Traylor*¹, G.L. Cromwell¹, M.S. Plunkett¹, M.D. Lindemann¹, and D.A. Knabe², ¹University of Kentucky, Lexington, ²Texas A&M University, College Station.

Ileal-cannulated pigs were used to assess dietary levels of phytase (Natuphos; BASF, Mt. Olive, NJ) on the apparent and true digestibility of Ca, P, CP, and amino acids in dehulled soybean meal (SBM) analyzing .39% Ca, .70% P, 48.8% CP, and 3.17% lysine. T-cannulas were

surgically placed in the terminal ileum of 14 pigs (25 kg BW). Following a 14-d recovery, four diets consisting of 30.5% SBM, starch, minerals and vitamins (.50% Ca, .40% P, 14.6% CP, .95% lysine) with 0, 500, 1,000, or 1,500 units of phytase/kg were fed. A casein-starch diet low in CP (4.4%), Ca (.03%), and P (.05%) was used to estimate endogenous Ca, P, CP, and amino acids. Two additional diets (data not shown) were included as part of a larger coordinated study. Cr_2O_3 (.5%) was used as an indicator. The seven diets were fed at .09 kg/kg BW^{.75} daily during seven periods in a 7 x 7 replicated Latin square (14 observations/diet). Apparent ileal digestibility of Ca and P tended to increase

quadratically with increasing level of phytase (Ca: 64, 68, 69, 69%, ns; P: 50, 64, 67, 70%, $P < .01$). Apparent digestibility of CP and most of the amino acids increased slightly with 500 units/kg of phytase, but not at the higher levels (CP: 82.5, 83.4, 80.9, 82.2%; lys: 89.9, 90.7, 88.8, 89.7%; thr: 80.5, 81.3, 78.7, 79.8%; trp: 89.3, 90.9, 87.7, 88.9%; met: 90.2, 90.6, 89.0, 89.4%; cubic, $P < .05$ to $P < .10$). True digestibility of Ca, P, CP, and amino acids followed similar trends (e.g., Ca: 69, 73, 75, 75%; P: 54, 69, 71, 74%; CP: 89.8, 90.8, 88.2, 89.6%; lys: 93.2, 94.0, 92.1, 93.0%). The results indicate that phytase had little effect on the apparent or true digestibility of amino acids in SBM, except for a slight numerical improvement from 500 units/kg of phytase (mean of .8 of a percentage point for the 10 essential amino acids). Phytase increased the apparent and true digestibility of Ca and P in SBM diets, with most of the improvement at the 500 units/kg level of phytase.

Key Words: Pigs, Soybean Meal, Digestibility

720 The effects of phytase supplementation to growing-finishing diets containing wheat middlings. N. Bekiaras*¹ and G. Appar¹, ¹*Southern Illinois University, Carbondale.*

An experiment was conducted using 54 crossbred pigs (initial wt 28.3 +/- 0.98 kg) to evaluate the efficacy of phytase addition to grower-finisher diets containing wheat middlings. There were 3 dietary phases during the experiment, 2 grower diets, fed during wk 1-2 and 3-4, respectively and a finishing diet fed during wk 5-7. Pigs were randomly allotted to either a control ration or a ration lacking inorganic phosphorus source with 500 FTU/kg phytase added. The phase 1 diet contained 4% wheat middlings, phase 2 contained 9%, and the phase 3 diet 10%. Chromic oxide was added to all diets as an indigestible marker for determination of nutrient digestibility. Pigs were weighed, feed intake measured and feed efficiency calculated every 2 wk. Random fecal samples, pooled by pen, were obtained during two 7-d collection periods during dietary phases 2 and 3, and analyzed for DM, Ca, P, Cu and Zn concentrations. Digestibility estimates were calculated by use of the indicator method. Treatments did not affect ($P > .10$) ADG or ADFI. Gain to feed ratios were greater for control animals than phytase supplemented pigs during phase 2 ($P < .05$), however the ratios did not differ at any other point during the trial. Dry matter digestibility was not different during phase 2, but was higher for pigs fed diets supplemented with phytase during phase 3 ($P < .01$). Digestibility of Ca was similar during phase 2, but was higher in pigs fed phytase during phase 3 ($P < .01$). Phosphorus digestibility was greater for pigs fed phytase supplemented diets during both phase 2 ($P < .05$) and phase 3 ($P < .01$). Although digestibility estimates for Cu and Zn differed between treatments, the data were unreliable and excluded from further analyses. Phytase addition to diets containing wheat middlings enabled growing-finishing pigs to have growth performance comparable to pigs fed diets containing wheat middlings with inorganic P. The addition of phytase resulted in lower concentrations of Ca and P in the excrement, presumably due to increases in absorption and utilization.

Key Words: Phytase, Pigs, Indirect digestibility

721 Use of phytase to improve nutrient digestibility in growing finishing pigs fed diets containing cottonseed meal. M. J. Azain, R. D. Jones, A. Phositimpagul, M. A. Froetschel, and H. E. Amos, *University of Georgia, Athens.*

Cottonseed meal (CSM) represents a potential substitute for soybean meal (SBM) as a protein source in swine and poultry rations. While CSM at 41% crude protein (CP) compares favorably to the crude protein content of SBM (49% CP), its amino acid profile and availability, as well as its energy content and presence of gossypol have limited its use. The objective of this work was to determine if phytic acid played a role in the reduced nutrient availability in diets formulated to contain 20% CSM. In a preliminary study, it was determined that the performance of pigs (50-105 kg) fed diets with CSM that were formulated on an available nutrient basis was equivalent to that of pigs fed corn-soybean meal based diets. In a second study, diets containing 20% CSM with adequate and marginal dietary phosphorus (DP), with and without 600 U of phytase (PT) were fed in two phases (45-75 kg, 75-105 kg). Diets were formulated to contain 0.61% and 0.48% available lysine in Phase I and II respectively. Total lysine was 0.93 and 0.68 % in these diets. The goal was to determine if phytase would indirectly increase protein or energy digestibility through its action on phytic acid. Growth performance was not different between diets. The lack of a difference is

likely accounted for by the failure to sufficiently reduce available nutrients to challenge the pigs. However, there were significant differences in digestibility. Digestibility was determined using chromic oxide as a marker at the mid point of each diet phase. In phase I, DP had no effect, but PT addition improved protein ($P < 0.01$) and energy ($P < 0.001$) digestibility. There was a DT x PT interaction ($P < 0.05$) on protein digestibility that was due to improved PT action in the adequate DP diet vs. the marginal. Both DP ($P < 0.001$) and PT ($P < 0.001$) improved phosphorous digestibility and there was an interaction ($P < 0.001$). The effects of treatment on digestibility were less evident in the Phase II diets, but trends ($P < 0.20$) for improved protein and energy digestibility were noted. These results indicate that phytase addition to CSM containing diets improves macronutrient and phosphorous availability. The support of the Georgia Cotton Commission, BASF and the Southern Cotton Oil Company is gratefully acknowledged.

Key Words: Cottonseed meal, Digestibility, Pig

722 Comparison of two genetically modified phytase sources fed to grower pigs. B. C. Robbins*¹, J. S. Radcliffe¹, T. L. Veum², J. P. Rice¹, and E. T. Kornegay¹, ¹*Virginia Polytechnic Institute and State University*, ²*University of Missouri, Columbia.*

Two hundred fifty-six crossbred pigs were used in a 6-wk experiment to compare the efficiency of two genetically modified phytases supplemented to grower pig diets. At an average initial weight of 28 kg, pigs were randomly allotted to eight dietary treatments. There were eight replicate pens of each diet, with two barrows and two gilts per pen. All diets were corn-soybean meal based and were fed in mash form. Diet 1 served as the positive control diet containing adequate levels of P and Ca (NRC, 1998). Diet 2 served as the negative control, having no added inorganic P (.35% P, .40% Ca). Diets 3, 4, and 5 consisted of diet 2 plus 250, 500, or 1,000 U/kg of source A phytase, respectively. Diets 6, 7, and 8 consisted of diet 2 plus 250, 500, or 1,000 U/kg of source B phytase, respectively. Individual BW and pen feed consumption were recorded bi-weekly. Pigs had ad libitum access to feed and water. During the last week of the 6-wk test, pen fecal samples were collected from each pen twice daily on three different days. At the end of wk 6, two barrows in each pen were slaughtered for collection of third metacarpals. The addition of source A or B phytase increased ADG ($P < .01$), metacarpal shear force ($P < .001$) and ash ($P < .001$), and Ca ($P < .05$) and P ($P < .001$) digestibility. Differences in the efficacy of source A and B phytase were observed for ADG ($P < .01$), and metacarpal shear force ($P < .05$) and ash ($P < .001$). Pigs fed diets supplemented with the source A phytase had larger improvements in ADG compared to pigs fed diets supplemented with source B phytase. However, bone parameters responded more favorably when source B phytase was fed. The P equivalency values of both phytase sources, based on phytase and P equations for ADG, P digestibility, metacarpal shear force and ash, showed that 500 U of phytase/kg of diet from either source can replace approximately .09% P from inorganic phosphate.

Key Words: pigs, phytase, digestibility

723 The effects of microbial phytase on mineral, amino acid, and energy digestibilities in grow-finish pigs fitted with steered ileo-cecal valve cannulas and fed corn-wheat-soybean meal, corn-wheat-canola, or corn-sorghum-soybean meal based diets. J. S. Radcliffe*, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

Twelve crossbred barrows fitted with steered ileo-cecal valve cannulas, used in a paired 6 x 6 Latin square design, were fed corn-wheat-soybean meal (CWS), corn-wheat-canola (CWC), or corn-sorghum-soybean meal (CSS) based diets with or without 500 U of added phytase/kg of diet. Each 14-d period consisted of a 7-d adjustment followed by a 3-d total collection, a 12-h ileal digesta collection, a 3-d readjustment, and a second 12-h ileal digesta collection. Pigs were individually housed in metabolic pens (1.2m x 1.2m). Pigs had ad libitum access to water and feed was supplied at a level of 9% of metabolic BW ($BW^{.75}$). The addition of microbial phytase to all diet types improved the apparent total tract digestibility (ATTD) of P ($P < .001$) and the apparent ileal digestibility (AID) of P ($P < .001$), Asp, Thr, Ser, Ala, Tyr, Phe, Lys, and Arg ($P < .001-.05$), and tended to improve Gly AID ($P < .1$). Amino acid AID were improved an average of 1.47 percentage units. Pigs fed CWC based diets had lower ($P < .001$) ATTD of P, DM, and energy, compared

to pigs fed CWS or CSS based diets. Phosphorus ATTD was higher for pigs fed CWS based diets compared to pigs fed CSS based diets. Pigs fed the CWS based diets had higher ($P < .001$) AID of all amino acids measured compared to pigs fed CWC or CSS based diets. The AID of Glu, Pro, Gly, Cys, Met, and His were lower ($P < .001$) for pigs fed the CSS based diets compared to the CWC based diets. An interaction of phytase and diet type was observed for the ATTD of Ca ($P < .02$) and the AID of Ca ($P < .1$), Met ($P < .05$), and Val ($P < .01$). The AID and ATTD of Ca were improved in all diet types by the addition of phytase, but the magnitude of the response was greater in the CSS based diets. The AID of Met and Val was improved when phytase was added to the CWS and CWC based diets, but decreased when phytase was added to the CSS based diet.

Key Words: pigs, phytase, amino acids

724 The effects of microbial phytase on mineral, amino acid, and energy digestibilities in grow-finish pigs fitted with SICV cannulas and fed corn-soybean meal, corn-soybean meal-wheat midds, or corn-soybean meal-meat and bone meal based diets. J. P. Rice*, J. S. Radcliffe, B. C. Robbins, R. S. Pleasant, and E. T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

Twelve crossbred barrows fitted with steered ileo-cecal valve (SICV) cannulas were used in a paired 6 x 6 Latin square design to test the effects of added phytase on mineral, amino acid, and energy digestibilities. Pigs had ad libitum access to water and feed was supplied at 9% of metabolic body weight ($BW^{.75}$) in two daily feedings. Pigs were fed corn-soybean meal (CS), corn-soybean meal-wheat midds (CSW), or corn-soybean meal-meat and bone meal (CSMB) based diets with or without 500 U of phytase/kg of diet. Each 2-wk period consisted of a 7-d adjustment, a 3-d total collection, a 12-h ileal digesta collection, a 3-d readjustment period, and a second 12-h ileal digesta collection. Pigs were individually housed in metabolic pens (1.2m x 1.2m). Upon analysis, diets formulated to contain 500 U of added phytase/kg of diet contained an average of only 319 U/kg of the diet. Wheat contributed an additional 250 U of endogenous phytase activity/kg of diet in the CSW based diets. The addition of microbial phytase to all diet types increased ADG ($P < .05$) and tended to increase feed efficiency ($P = .056$). Phytase addition also increased apparent total tract digestibility (ATTD) and apparent ileal digestibility (AID) of Ca ($P < .001$) and P ($P < .001$), but had no effect on amino acid AID. Pigs fed the CSMB based diet had higher ($P < .05$) ATTD and AID of Ca and P compared to pigs fed the CS or CSW diets. Energy ATTD was higher ($P < .05$) for pigs fed the CSMB based diet compared to pigs fed the CSW based diet. The AID of Asp, Thr, Ser, Glu, Gly, Ala, Met, Tyr, His, and Lys were affected ($P < .01$) by diet type. However, no diet was consistently superior to any other diet with regards to amino acid AID. The results of this study demonstrate that phytase improves Ca and P digestibilities equally in CS, CSW, and CSMB based diets.

Key Words: pigs, phytase, amino acids

725 Effects of Hemicell[®] addition to corn-soybean meal diets on energy and nitrogen balance in growing pigs. L. A. Pettey*, S. D. Carter, and B. W. Senne, *Oklahoma State University, Stillwater.*

In previous studies, we have shown that the addition of Hemicell[®] (β -mannanase; ChemGen Corp., Gaithersburg, MD) to corn-SBM diets improved G:F in weanling and finishing pigs, and this response was similar to that observed when soybean oil was added to increase ME by 100 kcal/kg. Therefore, a 22-d experiment was conducted to determine the ME concentration and N digestibility of a diet with added Hemicell[®]. Five groups of 4 littermate barrows (31.3 kg BW) were allotted randomly by weight to four dietary treatments. Treatments were: 1) a corn-SBM based diet as a control (1.10% Lys), 2 and 3) as 1 with corn-starch (CS) added to the daily ration to increase ME by 100 and 200 kcal/kg, respectively, and 4) as 1 with Hemicell[®] (.05%). Calculated ME concentrations of Diets 1, 2, 3, and 4 were: 3.32, 3.42, 3.52, and 3.32 Mcal/kg, respectively. Pigs were housed individually in metabolic chambers and equally fed within litter. The total collection of feces and urine were conducted during two 5-d periods (d 3-7, d 18-22). GE of the diets were: 4.45, 4.55, 4.65, and 4.44 Mcal/kg DM. There were no period x treatment interactions; therefore, the data were pooled across periods.

ADFI and GE intake increased linearly ($P < .01$) with increasing addition of CS, but there were no differences between pigs fed the control diet and the diet with Hemicell[®]. Total dry matter fecal excretion, fecal energy losses, total urine excretion, and urinary energy losses were similar for the four diets; however, DE concentrations increased linearly ($P < .01$) with increasing CS addition. ME of the four diets, on a dry matter basis, were: 3.84, 3.98, 4.07, and 3.83 Mcal/kg. Addition of CS linearly increased ($P < .01$) ME concentration, but the addition of Hemicell[®] had no effect. Also, N absorption and retention, as a percentage of intake, were similar ($P > .10$) among the four treatments. Although Hemicell[®] has been shown to improve efficiency of feed utilization, the enzyme appears to have no effect on the ME concentration or N digestibility of a corn-SBM diet.

Key Words: Enzyme, Metabolizable energy, Pigs

726 Effect of supplemental enzyme in barley with low, medium, and high DE content fed to grower pigs. R.T. Zijlstra*¹, B.K. Sloan², and J.F. Patience¹, ¹*Prairie Swine Centre Inc., Saskatoon, Canada,* ²*Aventis Animal Nutrition, Atlanta, GA.*

A 20% range exists in DE content of barley, which is caused primarily by changes in concentrations of fibrous fractions. The project was designed to determine if responses in dietary energy (E) and AA digestibility in grower pigs to supplemental enzymes that degrade fibrous fractions depend on the specific barley sample. Samples of barley with a predicted range of DE content and hull-less barley were selected using chemical characteristics and a near infrared spectroscopy calibration. In two studies, barley samples were included at either 96% (Exp. 1) or 66% of the diet with 25% soybean meal and 5% canola meal (Exp. 2), with or without enzyme (RovabioTM Excel; 500 U β -glucanase/kg diet). Grower pigs were cannulated at the distal ileum; feces and ileal digesta were collected in three periods ($n = 6$). In Exp. 1, enzyme supplementation improved apparent fecal E-digestibility 7% for medium-DE ($P < 0.01$) and 3% for high-DE barley ($P < 0.05$), and apparent digesta E-digestibility 13% for medium-DE ($P < 0.01$) and 8% for high-DE barley ($P < 0.05$). Enzyme supplementation improved apparent digesta total-essential AA-digestibility 10% for medium-DE ($P < 0.01$) and 8% for high-DE barley ($P < 0.05$). In Exp. 2, enzyme supplementation improved apparent fecal E-digestibility 2% for barley 1 ($P < 0.05$), 3% for barley 2 ($P < 0.01$), and 2% for hull-less barley ($P < 0.05$), but not for barley 3 ($P > 0.10$). Enzyme supplementation improved apparent digesta E-digestibility 7% for barley 2 and 6% for hull-less barley ($P < 0.01$) but not for barley 1 or 3 ($P > 0.10$), and apparent digesta total-essential AA-digestibility 3% for barley 2 ($P < 0.05$). Overall, hindgut fermentation diminished the increase in E-digestibility at the distal ileum. Enzyme supplementation improved digestibility of E and AA; however, responses depended on the specific barley sample. Thus, enzyme supplementation should be integrated with ingredient evaluation to maximize benefits of enzyme supplementation.

Key Words: Barley, Digestible Energy, Enzyme Supplementation

727 Processing of barley and enzyme supplementation in diets for early-weaned piglets. P. Medel*¹, F. Baucells², M.A. Latorre¹, M.I. Gracia¹, and G.G. Mateos¹, ¹*Dpto. Producción Animal. Universidad Politécnica de Madrid* , ²*Pinsos Bauccells. Barcelona.*

Two trials were carried out to study the influence of heat-processing (HP) of barley and enzyme supplementation (ES) of diets for early-weaned piglets. There were 6 diets arranged as a factorial 2x3 with two types of HP of barley (raw vs cooked and flaked) and 3 levels of ES (0, 600 and 1,200 ppm). The enzyme complex used contained 3,100 U/g α -amylase (E.C. 3.2.1.1.), 275 U/g of β -glucanase (E.C. 3.2.1.6.) and 400 U/g of xylanases (E.C. 3.2.1.8.) and chromic oxide was used as undigestible marker to measure digestibility. A total of 120 male piglets weaned at 19 d were used in a 28-d Trial 1 (T1). In a second Trial (T2), four of the six diets of T1 (raw or HP barley at 0 or 600 ppm of ES) and 16 piglets were used to measure apparent ileal digestibility of starch, ileal viscosity of digesta, pH of stomach, cecum and colon, and cecum volatile fatty acids concentration (VFA). In T1 piglets fed HP barley grew faster and transformed feed into gain more efficiently than piglets fed raw barley (213 vs 184 g/d; $P = 0.05$, and 1.19 vs 1.08 g/g; $P = 0.09$, for growth and feed conversion, respectively) at 14 d after weaning, but the differences disappear thereafter. Productive performance was not affected by ES (391 vs 375 g/d and 1.24 vs 1.30 g/g for growth and

feed conversion with or without ES, respectively, $P > 0.05$). Total tract digestibility of organic matter, energy, and protein were not affected by treatment. In T2, both HP of barley and ES improved ileal starch digestibility by 0.83 and 0.56%, respectively ($P = 0.08$), but pH of stomach, cecum and colon, and ileal viscosity were not affected. Piglets fed HP barley had a higher acetic (1,217 vs 919 $\mu\text{g/g}$, $P = 0.07$) and a lower butyric (299 vs 322 $\mu\text{g/g}$, $P = 0.07$) concentration in the cecum than piglets fed raw barley. We conclude that HP of barley improved performance from 0 to 14 d after weaning, and modified the VFA production in the cecum at 14 d. Starch digestibility was improved by ES, but it had little effect on piglet performance traits.

Key Words: Barley Processing, Enzyme supplementation, Piglets

728 Fermentability of pig feed treated with enzymes from stomach and pancreas, and of chyme. E. Bauer^{*1,2}, B. Williams¹, C. Voigt^{1,2}, R. Mosenthin², and M. Verstege¹, ¹Wageningen Agricultural University, The Netherlands, ²Hohenheim University, Stuttgart, Germany.

Fermentation characteristics of enzyme-treated pig feed (EPF) was compared with chyme (CHY), to determine whether such treatment could lead to a material which might be representative of the digesta reaching the large intestine. The comparison was made between the fermentation kinetics of EPF, the untreated feed (PF) and CHY collected from pigs fed the same feed. The enzyme treatment of the pig feed was performed according to a modified Babinski method (1992), where the materials were incubated with a pepsin/HCl solution, followed by pancreatin, amylase, lipase and bile salts. CHY was collected daily over a period of four weeks from four ileally fistulated pigs which were fed the same standard PF rich in maize meal. Proximate and fibre analyses were determined for EPF, PF and CHY. Fermentation kinetics were analysed according to the cumulative gas production method (Theodorou et al., 1994). End-point products such as total gas, NH_3 and VFA were also measured. The parameters were tested for significance by an analysis of variance using the Tukey multiple range test. A comparison between EPF and PF showed that the enzyme treatment only caused minor changes ($P > .05$) in the final fermentability of the substrates. The DM loss during fermentation was lowest for the EPF ($P < .0001$). A comparison between the fermentation characteristics of EPF and CHY showed very clear differences. CHY produced less gas ($P < .0001$), and the time at which half of the gas had been produced, occurred later ($P < .0001$). The maximum rate of fermentation was slower for CHY ($P < .0001$). At the end of fermentation there tended to be more VFA and NH_3 for CHY ($P > .05$). These differences must be related to mechanisms which occur in the small intestine and which are probably not related to enzymatic digestion as such. In terms of fermentation characteristics, EPF is therefore not identical to CHY and cannot give a good approximation of the material reaching the large intestine.

Key Words: Pig feed, Enzyme-treatment, Fermentation kinetics

729 The effect of dietary selenium source and level on broodmares and their foals. K.M. Janicki*, L.M. Lawrence, T. Barnes, and C.I. O'Connor, University of Kentucky, Lexington.

Fifteen pregnant mares were blocked by foaling date and randomly assigned to one of three selenium (Se) supplements: 1 mg Se/d (I1) or 3 mg Se/d (I3) as sodium selenite, or 3 mg Se/d (O3) as Se-enriched yeast (Alltech, Inc., Nicholasville, KY). Mares received their treatments daily for approximately 55 d pre-foaling and 56 d post-foaling. Blood samples were taken from each mare prior to supplementation and at 2 wk intervals throughout the study, including at time of foaling. A single colostrum sample was taken from each mare prior to the foal suckling. Blood samples were obtained from foals at 12 h, 2, 4, 6, and 8 wk post-foaling. Serum and colostrum samples were assayed for IgG concentration. Mares were weighed approximately 1 wk prior to foaling. Mares and foals were weighed 12 h PF, and at 2 wk intervals for 56 d. Se amount or form did not affect colostrum IgG concentration or foal serum IgG concentration at 12 h. To adjust for pre-treatment differences in IgG concentration among groups, mare IgG data were analyzed for treatment differences using the initial IgG concentration as a covariate. Mare IgG concentrations were not affected by treatment at 4 or 2 wk pre-foaling, or at foaling. Failure of passive transfer occurred in two foals in treatment I3, and a third foal in this group did not complete the study. Consequently, serum IgG data from the remaining foals in group I3 and all foals in group O3 were combined and compared to foals

in group I1. Foals from mares receiving 3 mg Se/d (either I3 or O3) had higher concentrations of IgG at 2 wk ($P < .05$), and at 4 and 8 wk ($P < .1$) compared to foals from mares receiving I1. Average daily gain of foals (1.5 kg/d for O3, 1.4 kg/d for I3, and 1.4 kg/d for I1) was not affected by treatment ($P \geq .1$). Placental weight and time to placental expulsion were not affected by Se amount or form. Supplementing mares with 3 mg Se/d may be beneficial by increasing foal IgG concentrations during the first few months of life when foals are most vulnerable to disease.

Key Words: Selenium, Broodmare, Foal

730 Effect of increasing available phosphorous levels on pig growth and carcass characteristics. S.A. DeCamp^{*1}, D.C. Kendall¹, C.T. Herr¹, K.A. Bowers¹, T.E. Weber¹, M.L. Cobb¹, C.J. Kendall¹, B.T. Richert¹, and A.L. Sutton¹, ¹Purdue University, West Lafayette, IN.

One-hundred and thirteen grow-finish pigs (60 barrows (B) and 53 gilts (G); initial BW=25.9 kg) were blocked by sex and initial BW to examine the effects of dietary available phosphorous (AP) on growth and carcass characteristics. Pigs were fed one of four AP diet sequences ad libitum for 103 days. Diet sequences consisted of four BW phases (P1, 25-47; P2, 47-66; P3, 66-90; and P4, 90-110 kg, respectively). Diets were corn-soybean meal based with supplemental phytase (P1 & P2, 480 phytase units/kg and P3 & P4 300 phytase units/kg). Levels of AP increased by .075% increments between diets. Dietary phytase AP sequences were: diet 1) 2.5, 2.0, 1.5, 1.0; diet 2) 3.25, 2.75, 2.25, 1.4; diet 3) 4.0, 3.50, 3.0, 2.25; and diet 4) 4.75, 4.25, 3.75, 3.0 g/kg. Pigs were weighed at the end of each phase and total feed consumed was recorded to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Carcass data and metacarpal bones were obtained at a commercial slaughter facility. There were no treatment effects on ADG (804, 838, 853, 840 g/d; respectively) during the grower period (P1 & P2). However, the grower period G:F tended to increase as AP increased (.409, .409, .423, .429, respectively; Lin. $P < .1$). ADG increased during the finisher period (P3 & P4) as AP increased (759, 783, 793, 810 g/d, respectively; Lin $P < .05$). Finisher G:F increased as AP increased (.284, .286, .289, .298, respectively; Lin. $P < .05$). Overall (d0-103) ADG increased as AP increased (781, 810, 822, 824 g/d, respectively; Lin. $P < .01$). Overall G:F also increased as AP increased (.332, .334, .340, .349, respectively; Lin. $P < .05$). Last lumbar backfat decreased linearly with increasing AP (20.7, 20.8, 18.6, 17.4 mm, respectively; $P < .05$). Percent lean tended to increase as dietary AP increased (53.6, 53.8, 54.1, 54.5%, respectively; Lin. $P < .1$). B had greater overall ADG (836 vs. 782 g/d, $P < .05$) and backfat thickness (24.1 vs. 20.5 mm, $P < .01$) but reduced percent lean (53.3 vs. 54.8%, $P < .01$). When corn-soy diets contain supplemental phytase, grower and finisher pig ADG and G:F were optimized with .425% and .30% phytase AP.

Key Words: pigs, phytase, phosphorous

731 Dietary available phosphorus needs of high lean pigs fed from 9 to 119 kg BW. T.S. Stahly, T.R. Lutz*, and R.D. Clayton, Iowa State University, Ames.

Eighteen sets of six littermate barrows or gilts from a high lean strain were used to determine the dietary available phosphorus (AP) needs for high lean pigs fed from BW of 9 to 119 kg. Pigs were weaned via a SEW scheme, individually penned, and fed a diet containing .16% AP from weaning to 9 kg. Pigs were then self-fed one of six dietary AP concentrations during each of four stages of growth; S1, 9 to 37; S2, 37 to 65; S3, 65 to 92; S4, 92 to 119 kg BW. The basal diets in the four respective stages of growth contained .16, .128, .102, .082% AP which were supplemented with five incremental amounts of AP equivalent to S1, .08; S2, .064; S3, .051; S4, .041% AP. Dietary AP concentrations were achieved by the substitution of mono-dicalcium phosphate for starch while the calcium to AP ratio was maintained at 2.5:1, 2.25:1, 2:1, and 2:1 for the four stages of growth, respectively. As dietary AP concentration increased, ADG increased linearly in S1 (587, 659, 680, 693, 697, 692 g/d; $P = .01$) and S4 (647, 869, 859, 827, 932, 930 g/d; $P < .01$), and quadratically in S2 (828, 968, 964, 966, 983, 959 g/d; $P < .01$) and S3 (810, 970, 967, 996, 1034, 974 g/d; $P < .01$). As dietary AP concentration increased, gain:feed also was improved quadratically in S1 (.603, .630, .658, .643, .645, .635 g/g; $P < .01$), S2 (.410, .449, .442, .434, .444, .420 g/g; $P < .01$), S3 (.313, .337, .354, .348, .352, .338 g/g; $P = .08$), and S4 (.235, .280, .289, .279, .299, .299 g/g; $P = .03$). Based on these data,

it can be concluded that the dietary concentration of AP necessary to maximize the efficiency of feed utilization in high lean pigs (barrows and gilts) growing from 9 to 37, 37 to 65, 65 to 92, and 92 to 119 kg BW should be .32, .192, .205, and .164 to .245%, respectively.

Key Words: Pigs, Phosphorus, Growth

732 Minimum biological capacity for phosphorus excretion in pigs. B. R. Frederick* and T. S. Stahly, *Iowa State University, Ames.*

Pigs (24 barrows) were allowed ad libitum access to semi-purified diets consisting of highly digestible sources of phosphorus (P, non-phytate) and nitrogen (N, ideal amino acid ratios relative to lysine). Dietary P and N were initially provided for 4 d at constant concentrations of .70% and 3.41%, respectively. Pigs were then fed control concentrations or lowered concentrations of P and/or N every 2 d for 8 d to achieve minimal excretion of digested P (<2% of dietary total P intake as inorganic P) and N (<10% of dietary N intake as urea) in the urine. Control P and N concentrations ranged from .70 to .85% and 3.41 to 3.74%, respectively. P and N concentrations were lowered in increments of approximately .03 and .40%, respectively, to achieve minimum dietary concentrations ranging from .61 to .65% and 2.12 to 2.54%, respectively. The process was then reversed and dietary P and N concentrations were raised every 2 d for 10 d to equal the control dietary N and P concentrations. Dietary P and N concentrations were achieved by altering the contribution of a calcium (Ca)-P (CaCO₃, NaPO₄) mix and protein mix (whey proteins, casein, amino acids) with an energy (cornstarch, corn oil, dextrin) and vitamin-mineral mix. All mixes contained a 2:1 total Ca to non-phytate P ratio. Based on two slope breakpoint analysis, the inflection point for body P retention per unit of digested P (dP) intake was achieved at an intake of .563±.020 g of dP/BW, kg^{.75} (MBW)/d. Phosphorus excretion of pigs with intakes at or below the inflection point consisted of .037±.006 g of P/MBW/d of urinary P regardless of P intake and an average of .222 g of P/MBW/d of undigested fecal P, which was highly dependent on P intake (29.8±.9% of total dietary P). P excretion at intakes above the inflection point increased urinary P, representing 48.5±5.0% of dP intake. Dietary P intakes below the inflection point maximizes efficiency of dP for P retention while minimizing urinary P excretion.

Key Words: Pigs, Phosphorus, Excretion

733 Boron affects growth performance and nutrient metabolism in growing barrows. T.A. Armstrong* and J.W. Spears, *North Carolina State University, Raleigh.*

An experiment was conducted to evaluate the effects of boron (B) on growth performance, bone mechanical properties, and the retention and excretion of nutrients. Thirty-six barrows were weaned at approximately 21 d of age and randomly assigned to receive one of three dietary treatments. Treatments consisted of: 1) low B basal diet (control), 2) control + 5 ppm B, and 3) control + 15 ppm B. Boron was supplemented as sodium borate. Barrows remained on their respective experimental diets throughout the nursery (35 d) and beginning of the grower (30 d) phases of production. Following the 30 d grower period, 8 barrows per treatment were transferred to stainless steel metabolism crates. Barrows had an adjustment period of 7 d, followed by a 7 d total collection of urine and feces. All barrows were fed at 90% of the ad libitum grower intake of the control animals during the adjustment and collection periods. Barrows were weighed and feed consumption was determined at the end of the nursery and grower periods. Blood samples were obtained from each barrow at the end of each phase. At the end of the collection period, barrows were sacrificed and femurs harvested for the assessment of bone mechanical properties. Boron increased (P < .05) ADG and ADFI during the nursery and grower phases; however, B did not affect feed efficiency during these production phases. The 5 ppm B treatment decreased (P < .06) the concentration of triiodothyronine in the serum during the grower phase. Boron did not affect the bone ash percentage, but the supplementation of 15 ppm B did increase (P < .10) bone stress or the intrinsic strength of the femur. The 5 ppm B treatment caused an increase (P < .08) in fecal N excretion, which resulted in a decrease (P < .08) in N retention. The 5 ppm B treatment resulted in a decrease (P < .09) in urinary Ca excretion, but had no effect upon Ca retention. These data indicate that B supplementation to pigs can stimulate growth, increase bone strength, and alter nutrient metabolism.

Key Words: Boron, Pigs

734 Strategic application of Aureomycin chlortetracycline in lactation diets reduces sow mortality and improves reproductive performance. J. Deen*¹, S. Keay², R.D. Boyd², D. Appleton², P. Matzat³, and T. Wolff³, ¹*University of Minnesota, St. Paul,* ²*PIC USA, Franklin, KY,* ³*Roche Vitamins Inc., Parsippany, NJ.*

Sow mortality has significantly increased in the U.S. due to a number of risk factors that appear to be herd specific. The farrowing-lactation time frame is a period of high risk. This study examined strategic addition of chlortetracycline (CTC) to the lactation diet in a herd that experienced high (14%) annual mortality of varied etiologies. Treatments were imposed in alternate farrowing groups and involved feeding either no antibiotics (Control) or CTC in the lactation diet. The level of CTC was 0.734 g/kg diet (22 mg/kg BW). The medicated diet was fed on a 2-week on, 1-week off schedule. The data set involved 1944 Control and 1966 CTC sows (28 farrowing groups, average parity 3.05 and 2.99, respectively) for the current and subsequent reproductive cycle. The proportion of farrowed sows that subsequently died decreased by 2.75% (6.87 vs 4.12%), that were culled decreased by 2.9% (14.34 vs 11.47%) and that were re-bred and farrowed increased by 5.4% (62.21 vs 67.64%). During next farrow, stillbirths declined by 0.10 pigs/litter (P<.01) and liveborn increased by 0.23 pigs/litter (P<.06). Older sows died to a greater extent (Linear, P<.05). Approximately 52% of sow attrition occurred within 21 d of farrow. Strategic addition of CTC to lactation diets decreased the probability of sows dying by 41% (P<.001) and of being culled by 20% (P<.05). It increased the probability of farrowing by 8% (P<.02). The impact of CTC on increased sow retention (decreased maiden female entry rate) and subsequent reproduction was predicted to improve herd average pigs born alive/litter by: +.10 for lower stillbirth, +.17 for increased litter size, +.40 for decreased sow death and culling and +.10 for improved farrowing rate. This study illustrates that strategic CTC addition improves sow viability when significantly challenged. It confirms prior data that reproduction is improved with CTC use.

Key Words: Pigs, Sow viability, Antibiotics

735 Effects of diet acidification on sow and litter performance. C. W. Starkey*¹, J.D. Hancock¹, J.S. Park¹, C. Hankins², K. Herkelman², B. Moody², and R. L. Odgaard³, ¹*Kansas State University, Manhattan,* ²*Farmland Industries,* ³*Kemin Industries, Des Moines, IA.*

A total of 314 sows (PIC line C22) were used in a 18d lactation experiment to determine the effects of diet acidification on sow and litter performance. The sows (parities 1 to 5) were fed three times/d to approximate ad-libitum consumption. Treatments were a corn-soybean meal-based control and the control with .5% of a cocktail of phosphoric, lactic, and citric acids (KemgestTM) and .5% of a cocktail of fumaric, lactic, citric, propionic, and formic acids (Acid LacTM). The diets were formulated to 1% lysine, 1% valine, .9% Ca, and .8% P and were introduced a minimum of 2 d prior to farrowing. Sows fed diets with Acid Lac lost less weight (P < .01) than sows fed Kemgest, however, no differences were observed in days to rebreeding or sow ADFI. Also no differences (P > .10) were observed for piglets born alive, stillbirths, mummies, piglet survivability, and litter weight gain among sows fed the various dietary treatments.

Item	Control	Kemgest	Acid Lac	SE
Sow ADFI, kg	6.0	6.0	6.1	.1
Sow weight loss, kg	36.8	37.7	32.3	1.4
Days to rebreeding	7.3	7.0	6.6	.6
Born alive	10.4	10.2	10.8	.3
Stillborn	1.0	1.0	1.2	.1
Mummies	.4	.4	.4	.1
No. pigs at 24h	11.0	10.9	10.9	.04
No. pigs at weaning	8.7	8.7	8.9	.1
Survivability, %	78.9	80.1	81.6	1.2
Litter weight gain, kg	29.2	29.9	30.0	.9

Key Words: Sows, Acidifiers, Lactation

736 Limiting amino acids and ideal amino acid pattern for lactating sows. S. W. Kim*, D. H. Baker, and R. A. Easter, *University of Illinois, Urbana IL/USA.*

A simple approach was applied to determine limiting amino acids for lactating sows. Twenty-eight primiparous sows were fed 39.3 g/d lysine and 11.5 Mcal/d ME. Groups of four sows were allotted to litter-size treatments of 6, 7, 8, 9, 10, 11, or 12 by cross-fostering as needed within 48 h postpartum. Sows were killed on d 21 of lactation. Carcass, liver, gastrointestinal tract, reproductive tract, mammary gland, and other viscera were separated, weighed, ground, and analyzed for dry matter, crude protein, and amino acids. Simple linear equations were obtained for each amino acid within tissues as a function of litter size. Amino acids from carcass, liver, gastrointestinal tract, reproductive tract, and other viscera were mobilized as litter size increased (e.g., lysine mobilization was 31.2, .56, 1.12, .44, and .64 g per pig, respectively, for the 21-d lactation). Amino acids were accreted to mammary glands as litter size increased (e.g., 2.65 g lysine per pig for the 21-d lactation). Milk production needs were estimated (e.g., 49.9 g lysine per pig for the 21-d lactation). The quantity of each amino acid required additionally as litter size increased was obtained from the difference between amino acid needs for milk production and mammary gland growth and those provided from tissue mobilization. The relative ratio among amino acids that are required additionally was compared with the relative ratio of amino acid that can be provided from a common lactation diet. From the comparison, it was shown that lysine and threonine are the first-limiting amino acids, followed by valine, when sows are provided corn-soybean meal based diets during lactation. The calculations suggest that when threonine and lysine requirements are met, other essential amino acids should be sufficient for lactating sows that are fed corn-soybean meal based diets.

Key Words: Limiting Amino Acids, Lactating Sows, Ideal Amino Acid Pattern

737 Response of gilts with naturally diverse body composition to low and high dietary lysine (protein) during lactation. P.C. Penny*¹ and H.M. Miller², ¹*JSR Healthbred Ltd, Southburn, UK,* ²*University of Leeds, School of Biology, Leeds.*

The objective of this study was to determine whether lean vs fat gilts, both derived from a high lean genotype (JSR Healthbred) were equally able to utilise lactation diets varying in total lysine content. Two hundred and thirty gilts were assigned to a 2 x 2 factorial arrangement of body type and dietary lysine. Gilts were weighed and P2 backfat thickness measured (65 mm from the midline over the last rib) at service and farrowing. Gilts with a P2 \leq 15 mm at service and P2 \leq 20 mm at farrowing were classed as lean (L), those with a P2 > 15 mm at service and P2 > 20 mm at farrowing were identified as fat (F). Within L and F body type, gilts were randomly assigned to one of two isoenergetic (3.4 Mcal/kg) diets with low lysine (LL) 0.7 % total lysine or high lysine (HL) 1.3 % total lysine. Gilts were fed twice daily to provide ad-libitum access to feed and number of piglets per gilt and litter weight were standardised on d1 postpartum. Of the 230 gilts, 174 remained within the same body composition classification and of these 19 did not complete a successful lactation. L gilts were lighter and leaner at farrowing (P < .001) compared to F (209.8 vs 226 kg and 17.7 vs 26.2 mm). P2 backfat loss during lactation was lower (P < .001) for L gilts (3.9 vs 6.1 mm) than F. There was also an interaction (P < .05) with L-HL and F-LL having lower backfat loss. Increasing dietary lysine had no effect on gilt BW loss between parturition and weaning for L vs F and LL vs HL. No differences were evident for litter start weight between LL and HL. Gilts on the LL diet produced a substantially lower total litter weight gain and individual piglet live weight at weaning (P < .01) compared to HL fed gilts (44.6 vs 49.3 kg and 7.1 vs 7.6 kg). ADFI was not different between either L and F body type or LL and HL (5.3 vs 5.4 kg and 5.3 vs 5.4 kg). These results demonstrate that gilts of both L and F body type are capable of utilising high lysine (protein) diets effectively during lactation.

Key Words: Gilts, Lysine, Lactation

738 Skeletal muscle mobilization in lactating sows with divergent lactational protein loss. E. J. Clowes*, V. E. Baracos, and F. X. Aherne, *University of Alberta, Edmonton, Alberta, Canada.*

Skeletal muscle is mobilized during lactation in primiparous sows. To investigate possible mechanisms, an index of protein synthesis (RNA:DNA) and muscle free amino acid concentrations were studied in triceps of sows fed to lose divergent levels of body protein. Primiparous sows were randomly allocated to isocaloric diets (62 \pm 2.6 MJ DE/d) containing CP at 19.8% (n=8), 15.1% (n=7), or 11.9% (n=10). Litter weight, and sow live-weight and backfat were measured throughout lactation. Triceps muscle was biopsied 7 d prior to, and 12 and 23 d after parturition. A progressive body weight loss of 12.7, 17.0, and 28.2 kg (P = .002) was observed with decreasing level of dietary protein, but since all sows lost an equal amount of backfat, divergent levels of protein loss were achieved. Sows maintained similar litter growth rates in early lactation, but by the end of lactation litter growth rate declined and was 2.26, 2.44, and 2.73 \pm .15 kg/d in sows fed 11.9%, 15.1%, and 19.8% CP, respectively (P = .03). Muscle RNA:DNA declined (P < .001) between 7 d prior to and 12 d after parturition in all sows, and declined (P = .03) thereafter to d 23 only in sows with the greatest protein loss. Concentrations of muscle total free amino acid, and most individual amino acids, increased between 7 d prior to and 12 d after parturition, but declined again by d 23. Levels of muscle free valine were inversely related (P = .001; R² = .31) to muscle protein loss at the end of lactation, and were lowest in animals showing the greatest protein loss. These results imply an imbalance between amino acid supply and demand in late lactation, which limits lactational performance and suggests that valine may be particularly limiting. By contrast, muscle free glutamine levels showed opposite changes to valine and other amino acids; muscle glutamine levels rose during lactation and were highest in animals showing the greatest body protein loss. This may reflect an imbalance between the proportions of valine and glutamine leaving muscle and the levels of those amino acids required for milk protein synthesis.

Key Words: Sow, Lactation, Muscle Loss

739 Predictability of body weight changes in sows during gestation. D.R. Cooper^{1,2}, J.F. Patience*¹, R.T. Zijlstra¹, and M. Rademacher³, ¹*Prairie Swine Centre Inc.,* ²*University of Saskatchewan, Saskatoon, SK,* ³*Degussa-Huels AG, Hanau, Germany.*

The pork industry's focus on economic efficiency and environmental sustainability underscores the need for greater precision in defining nutrient requirements. The objective of this study was to validate a factorial approach to defining daily DE requirements for gestating sows. Feed allowance in gestation was determined factorially for 419 multiparous sows based on estimated daily DE requirements for maintenance (110 kcal DE/kg BW^{.75}), growth of conceptus and related tissue (411 kcal DE/d) and maternal BW gain (partitioned into protein and lipid deposition). Target net maternal BW gains were 35, 30, 20, 10 and 0 kg for parities 1, 2, 3, 4 and 5 or higher (5+), respectively. Total gain of the conceptus and reproductive tissues was assumed to be 20 kg for all sows. A barley-wheat-soybean meal gestation diet was provided once per day in quantities estimated to meet daily DE requirements. Sows gained an average of 10.6 \pm 1.3 (SEM) kg above the target total gestation BW gain. To further evaluate the factorial estimation of DE requirements, the daily DE intake for each sow was entered into the new NRC (1998) gestation model to compare actual vs. predicted changes in sow BW during gestation. The deviation between the predicted and actual gains (NRC prediction - actual BW gain) were -6.8 \pm .8, -6.2 \pm .8, -1.4 \pm 1.6, .1 \pm 1.4, 4.5 \pm 1.7, 1.1 \pm 2.0, 7.8 \pm 3.2 and 9.0 \pm 3.9 kg for parities 1 through 8, respectively. The coefficient of variation increased with increasing parity for both the predicted and actual BW gains in gestation. A positive correlation was found between actual BW gain in gestation and the number of piglets born (r = .37, .34, .50, .29 and .15 for parity 1, 2, 3, 4 and 5+, respectively; P < .05). A greater understanding of the relationship among BW changes, productivity and nutrient intake in gestation will improve the precision of gestation diet formation and hence, overall production efficiency and sustainability.

Key Words: Gestation, Sow, DE intake

740 Impact of reduced dietary trace minerals on mineral and anti-oxidant status in swine. G. M. Hill*¹, J. E. Link¹, J. W. Spears², and W. L. Flowers², ¹Michigan State University, East Lansing, ²North Carolina State University, Raleigh.

The presence of minerals in animal waste from dietary supplementation is often viewed as a threat to environmental sustainability. Therefore, the objective of this research was to determine if reducing dietary concentrations of zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) would alter mineral and antioxidant status of sows and their offspring through 3 parities. Crossbred gilts (n = 216) were weaned and assigned to diets meeting all known nutrient needs (NRC, 1988) with Zn, Cu, Fe, and Mn at (1) industry standard (minimum 15 ppm Cu, 100 ppm Zn and Fe, 40 ppm Mn) (IS), (2) reduced (5 ppm Cu, 25 ppm Zn and Fe, 10 ppm Mn) inorganic form (RI) or (3) reduced with 50% provided in the chelate form (RC). Pigs (n = 24, 1st parity; n = 18, 3rd parity) and sows after their 3rd parity (n = 18) were killed and tissues collected. Within age groups, tissue glutathione peroxidase and Mn superoxide dismutase (SOD) activity did not differ between treatments. However, Cu/Zn SOD activity was higher ($P \leq .001$) in heart and kidney of RC 3rd parity offspring than IS or RI (18 vs 12, 12 and 24 vs 13, 15 U/mg protein, respectively). Sows fed RC had lower heart Cu/Zn SOD than those fed IS diets. Liver Zn was higher ($P \leq .0003$) in 1st or 3rd parity pigs fed IS than those fed the reduced diets (60 vs 30, 30 ppm; 72 vs 52, 49 ppm). In sows, liver Zn was higher in those fed RC than IS ($P \leq .003$; 83 vs 66 ppm). Renal Cu was higher in IS 3rd parity pigs and IS and RI sows than RC for their respective age group ($P \leq .01$). Tissue Mn was not affected by dietary source or concentration. No measured parameter was outside the expected normal range. In conclusion, mineral source and concentration did not uniformly affect tissue concentration and antioxidant enzyme activity, and dietary Cu, Zn, Fe and Mn can be reduced in swine diets without affecting health.

Key Words: Swine, Antioxidant, Nutrient Management

741 Glutamine stimulates the synthesis of immunoglobulin IgG in Infected Early Weaned Pigs. J. Hernandez¹, A. Borbolla*¹, R. Mendoza¹, and G. García², ¹Facultad de Medicina Veterinaria y Zootecnia UNAM, ²Instituto de Biomédicas UNAM.

Glutamine has demonstrated its role as a fuel source for macrophages and other white cells; thus, improving the immune response mainly during stress and disease. The low activity of the immune system of the young pig prevents many producers from adopting early weaning strategies. Therefore, the objective of this study was to evaluate the role of glutamine on the production of IgG. Thirty-six pigs of 14 ± 2 d were weaned on diets formulated with 0, 0.50, 0.77 or 1.50% of glutamine. One week after feeding the experimental diets, all pigs were inoculated abdominally with *E. coli* (Serotype 066, 0.5×10^{10} CFU/kg wt). Every three days after inoculation, two pigs per treatment were killed. Blood samples were taken and necropsy of each animal was performed to evaluate signs of infection with the bacteria. Samples of blood were subject to ELISA test to detect the presence of antibodies specific for the bacteria. Glutamine supplementation increased ($P < .01$) serum IgG levels against *E. coli* antigens in a dose-response fashion (0.40, 0.99 y $1.32 \mu\text{g}$ with 0.50, 0.77 y 1.50 % of glutamine, respectively). Infection signs in the abdominal cavity were lower ($P < .05$) in the pigs that received 0.77 and 1.50% of glutamine, when compare with pigs in the control or 0.50 % groups. Glutamine supplementation in early-weaned pigs improves immune response against *E. coli* during the first two weeks after suffering the stress of weaning.

Key Words: Piglet, Early weaned pig, Glutamine

742 Dietary fat supplementation effects on in vitro nutrient disappearance and in vivo nutrient intake and total tract digestibility by horses. J.A. Bush*, D.E. Freeman, K.H. Kline, N.R. Merchen, and G.C. Fahey, Jr., University of Illinois, Urbana.

Addition of fat to the diet of the equine is a popular method of increasing energy density of the diet while reducing feed intake. The effects of dietary fat on in vitro nutrient disappearance in the equine were studied in Exp. 1 using a split-plot design within a 2×2 Latin Square. Two ponies were fed treatments consisting of alfalfa (ALF) alone (no fat-NF) or ALF plus 100 g/d corn oil (fat-F). Five substrates were used to determine IVDMD, IVOMD, in vitro NDF disappearance (IVNDFD), and

in vitro total dietary fiber (TDF) disappearance (IVTDFD). The substrates used included: ALF, tall fescue (TF), red clover (RC), soybean hulls (SBH), and rolled oats (RO). There were no significant effects on IVDMD, IVOMD, or IVTDFD due to fat supplementation. Addition of fat to the diet increased ($P < .05$) the disappearance of NDF in RO. Among substrates, IVDMD and IVOMD were highest ($P < .05$) for RO, followed by SBH, ALF, RC, and TF. In vitro NDF and TDF disappearance were highest ($P < .05$) for SBH, followed by RO, ALF, RC, and TF. In Exp. 2, the effects of varying levels of fat on nutrient intake and total tract digestibility were examined using a 4×4 Latin Square design. Four mature mares were fed a 60% forage-40% concentrate diet containing different concentrations of fat: control (C), 0% supplemental fat; 5% supplemental corn oil (5% CO); 10% supplemental corn oil (10% CO); and 15% supplemental corn oil (15% CO). Animals on the C treatment had the highest ($P < .05$) intake of alfalfa cubes and of DM and OM followed by those on the 10, 5, and 15% CO treatments, respectively. Animals consuming the 15% CO diet had the highest ($P < .05$) intake of fat, followed by those consuming the 10% CO, 5% CO, and C treatments, respectively. There were no effects ($P > .05$) of treatment on digestibilities of DM, OM, CP, NDF, or gross energy. Animals consuming the 15% CO diet had the highest ($P < .05$) fat digestibility, while those consuming the C treatment had the lowest fat digestibility, with the 10 and 5% CO treatments being intermediate. Fat in the form of CO had little effect on nutrient digestibility in the equine in vitro and in vivo.

Key Words: Equine, Fat, In Vitro Digestibility

743 Vitamin B₁₂ requirements of early weaned pigs. C.M.T. McDougall* and J.D. House, Department of Animal Science, University of Manitoba, Winnipeg.

Two trials were conducted in early weaned pigs to: 1) determine their vitamin B₁₂ requirement and 2) examine the effect of dietary antibiotics on their vitamin B₁₂ status. In the first trial, sixty pigs, weaned at 17 $\bar{1}$ d, were *ad libitum* fed a pelleted corn-soyabean meal-lactose based diet (devoid of vitamin B₁₂) supplemented with 0, 35, 70, 105 or 140 g vitamin B₁₂ kg⁻¹ diet, for 15-d. Average daily gain, average daily feed intake, feed efficiency ratio, and packed cell volume for the pigs were not influenced by the vitamin B₁₂ content of the diet (overall means \bar{n} SE = 0.200 \bar{n} 0.043 kg, 0.212 \bar{n} 0.036 kg, 0.939 \bar{n} 0.093, and 33.1 \bar{n} 3.1 %, respectively). However, plasma analysis revealed significantly lower vitamin B₁₂ (50 pg mL⁻¹ vs. 187, 168, 165, and 179 pg mL⁻¹ for the 35, 70, 105 or 140 g vitamin B₁₂ kg⁻¹ diet, respectively; $P < 0.05$) and higher homocysteine (35 moles L⁻¹ vs. 23, 26, 25, and 23 moles L⁻¹ for the 35, 70, 105 or 140 g vitamin B₁₂ kg⁻¹ diet, respectively; $P < 0.05$) concentrations in pigs given the vitamin B₁₂-unsupplemented diet. In the second trial, forty-eight pigs, weaned at 17 $\bar{2}$ d, were *ad libitum* fed the vitamin B₁₂-unsupplemented diet with or without 10 g of an antibiotic (ASP250) kg⁻¹ diet, for 15-d. Average daily gain, average daily feed intake, feed efficiency, packed cell volume, plasma vitamin B₁₂ and plasma homocysteine were similar for both the ASP250-unsupplemented and ASP250-supplemented pigs. These results indicate that the dietary vitamin B₁₂ requirement of the early weaned pig does not exceed 35 g vitamin B₁₂ kg⁻¹ diet and is not altered by the inclusion of an antibiotic. Future trials will further refine the early weaned pig's requirement for vitamin B₁₂, and evaluate this estimated requirement under commercial production practices.

Key Words: Vitamin B12, Early weaned pigs, Homocysteine

744 Effects of multiple stabilized enzymes on growth and performance of starter pigs. A. Gueye*¹, C. R. Richardson¹, and D. A. Haverkamp², ¹Texas Tech University, Lubbock, ²Natur's Way Inc, Horton, KS.

A series of five experiments were conducted using 21 d-old crossbred weanling pigs (9.48 \pm .36 kg) to determine the effects of an enzymemicrobial product (Multiple Stabilized Enzymes MSE) on growth and performance of starter pigs. In each experiment, 96 pigs (4 pens of 6 pigs each) were randomly assigned to 4 dietary treatments: A) control, B) MSE, C) MSE + 1% fat, and D) MSE + 2% fat. Pigs were housed in environmentally controlled pens with plastic slotted floors, and equipped with a nipple waterer and a self-feeder. Pig weights and feed intake were recorded at the beginning of each experiment and at day 14 and 28. Pigs were allowed *ad libitum* access to feed and water. All five experiments were pooled and the data analyzed with pen as the

experimental unit for the periods 0-14 d, 15-28 d, and 0-28 d. ADG, ADFI, and feed conversion were analyzed as a completely randomized design using initial weight as a covariate. For d 0 to d 14, treatment had no effect on ADG, but ADFI decreased ($P < .05$) for pigs fed MSE with increasing levels of fat as compared to the control group. Pigs fed MSE + 1% fat had an improved ($P < .05$) feed conversion as compared to the control. For d 14 to d 28, treatment had no effect on ADG or feed conversion, but ADFI decreased ($P < .05$) for pigs fed MSE + 1% fat. Overall (d 0 to d 28), treatment had no effect on ADG, but ADFI and feed conversion improved ($P < .05$) for pigs fed MSE + 1% fat as compared to the pigs in the control group. In summary, addition of MSE in starter pig diets resulted in decreased average daily feed intake, improved feed conversion, but had no effect on average daily gain.

Key Words: Pigs, Enzyme-microbial, Performance

745 Effect of dried porcine solubles on performance of lactating sows. L. J. Johnston^{*1}, S. K. Baidoo¹, G. C. Shurson¹, G. Keller², and R. D. Walker¹, ¹University of Minnesota, Morris, ²Nutra-Flo Protein Products, Sioux City, IA.

Mixed parity, maternal line sows ($n=119$) were studied to determine the influence of dried porcine solubles (DPS) on performance of lactating sows and their litters. DPS is a co-product of heparin extraction from porcine small intestines dried on a soybean hull carrier. Sows at the West Central (WCRC; $n=66$) and Southern (SRC; $n=53$) Research Centers were used for this experiment. Corn-soybean meal based diets were formulated to contain .9% total lysine and 0, 1.5, or 3.0% DPS added at the expense of corn. Sows were assigned to dietary treatments within center, farrowing group, and parity at parturition. Pigs were crossfostered irrespective of treatments by d 3 to achieve a minimum of nine pigs per litter. Creep feed was not offered to litters. Lactation length was 23.3 and 18 d at WCRC and SRC, respectively. The statistical model for analysis of all data included effects of diet, center, farrowing group within center, and parity as a covariate. Lactation length was used as a covariate for postweaning interval to estrus. There were no significant interactions between treatments and center or treatments and farrowing group. A linear increase ($P < .10$) in total feed consumed in the first 9 days of lactation (47.5, 52.0, 49.0 kg) and ADFI of sows over the entire lactation (6.07, 6.56, 6.32 kg) was observed for sows fed 0, 1.5 and 3.0% DPS. Litter size (9.33, 9.22, 9.08 pigs; $P < .40$) and weight (53.6, 52.4, 51.9 kg; $P < .75$) on d 18 of lactation were not affected by 0, 1.5 or 3.0% DPS, respectively. Days from weaning to estrus (4.67, 4.59, and 4.32; $P < .40$) were not influenced by inclusion of 0, 1.5 or 3.0% DPS, respectively. Percentage of sows displaying estrus by d 15 after weaning was 94, 95, and 97% for sows fed 0, 1.5, and 3.0% DPS, respectively. Under the conditions of this experiment, inclusion of DPS at 1.5 or 3.0% tended to improve feed intake of lactating sows but had no significant influence on litter performance. Improvements in sow feed intake due to DPS additions to the lactation diet warrant further investigation.

Key Words: Sows, Lactation, Dried porcine solubles

746 L-Carnitine increases muscle mass, bone mass and bone density in growing large breed puppies. K.L. Gross* and S.C. Zicker, Hill's Pet Nutrition, Inc. Topeka, KS.

Addition of L-carnitine to dog food (300 ppm DMB) during weight reduction in obese adult dogs has been shown to alter body composition, specifically increasing lean body mass. Dietary L-carnitine supplementation reduces daily fat accretion of growing pigs and accelerates growth rate, increases muscle and reduces fat in growing fish. We hypothesized that L-carnitine supplemented in the food of growing large breed dogs may reduce body fat mass and increase muscle mass. Forty six Labrador and Golden Retriever puppies from 6 different litters were fed either a L-carnitine-supplemented (300 ppm DMB) or unsupplemented growth food (Hill's Science Diet Large Breed Canine Growth) from weaning (8 wks of age) through 18 mo of age. Puppies were part of the Kansas Specialty Dog Service program (KSDS) and lived in homes with families. At 18 mo, the dogs returned to KSDS facilities to enter training programs to become assistance or guide dogs. Blood samples were collected at weaning, 6 mo, 1 yr and 18 mo of age for assay of carnitine. Body composition by DXA (Hologic QDR 2000) was determined at weaning and 18 mo. Plasma total carnitine concentration significantly increased from 23 nmol/ml at weaning to 47 nmol/ml at 18 mo in the L-carnitine supplemented pups ($P=0.0001$) but remained unchanged in the unsupplemented group. At weaning, both groups of pups weighed 3.4 kg had

3044 g of lean mass, 288 g of fat mass and 59 g of bone mass. At 18 mo, the L-carnitine supplemented pups had significantly more bone mass (926 vs. 794 g, $P=0.0004$), greater bone density (0.96 vs. 0.91 g/cm², $P=0.0019$), more lean body mass (23.9 vs 21.8 kg, $P=0.0131$) and were heavier (30.6 vs 28.0 kg, $P=0.0355$) than unsupplemented pups. Body fat mass (5.4 vs 5.1 kg) was unaffected by L-carnitine supplementation. L-carnitine supplementation to growing large breed dogs resulted in bigger dogs with more muscle, greater bone mass and stronger bones.

Key Words: Carnitine, Body composition, Dogs

747 Substitution of DL-Methionine by Methionine Hydroxy Analogue (MHA-FA) in the diet of weaned pigs. P.B. Lynch¹, M. Rademacher^{*2}, and P.G. Lawlor¹, ¹Teagasc, Moorepark Research Centre, Fermoy, Co. Cork, Ireland, ²Degussa-Hüls AG, Feed Additives Division, 63457 Hanau-Wolfgang, Germany.

Methionine hydroxy analogue free acid (MHA-FA) differs from DL-methionine in that the molecule has a hydroxy group rather than an amino group. As a source of methionine for poultry MHA-FA has been shown to have 0.65 efficacy relative to DL-methionine. The objective of the present study was to determine if 65 parts of DL-methionine can be replaced by 100 parts of liquid MHA-FA in a methionine deficient diet for pigs after weaning. Ninety six pairs of crossbred pigs (one male, one female), were blocked on weight at weaning (age 27.7 s.e.=0.1 days; weight 8.2 s.e.=0.1kg) and assigned to treatment in a randomised block design for a 16-day experimental period, commencing 12 days after weaning when mean weight was 10.6kg s.e. 0.1. A commercial piglet starter feed was fed in the pre-experimental period. The treatments were: (a) control diet - deficient in methionine, (b) control diet with added 0.65g DL-methionine per kg, and (c) control with added 1.0g MHA-FA per kg. The composition of the control diet was (g/kg) barley 75, wheat 200, dried cheese whey 125, herring meal 25, heat treated soyabean 160, peas 240, soya oil 25, maize starch 120, lysine HCl 2.75, L-threonine 2.0, L-tryptophan 0.5, minerals and vitamins 24.75. The diet was pelleted after steam-heating to 50°C and fed ad libitum. Daily feed intakes on the three treatments were 688, 735, 714; s.e. 12g, NS, daily liveweight gains were 432, 501 and 488; s.e. 10g; $P<0.01$ and feed:gain ratios were 1.61, 1.48, 1.48; s.e. 0.03; $P<0.05$ for control, DL-methionine and MHA-FA diets respectively. It is concluded that 100 units MHA-FA can substitute for 65 units of DL-methionine in diets for weaned pigs.

Key Words: Methionine, Hydroxy analogue, MHA

748 Effect of dietary supplementation with phyto-gen substances, carbadox, and colistin on performances and immune response in post-weaning pigs. G. Savoini^{*1}, G. Mancin¹, A. Agazzi¹, F. Cheli¹, A. Baldi¹, E. Monfardini¹, V. Sala¹, and V. Dell'Orto¹, ¹University of Milan, Italy.

Phytogen substances may be alternative to antimicrobials in weaned pig diets. We investigated the effects of supplementating postweaning piglets diet with phytogen substances (extract of Echinacea, genzian-root, essential oils of juniper and thyme, tannins and silicic acid) compared to carbadox and colistin on growth, blood parameters and immune response. Forty-eight Goland piglets, averaging 15 kg LW, were randomly allotted to three dietary treatments: carbadox (Cx) 50 mg/kg of feed as fed, colistin (Co) 120 mg/kg of feed as fed and phytogen substances (Ps) 300 mg/kg of feed as fed. Piglets weight was recorded at 0,10,20,30d. Feed intake of each dietary group was recorded daily. Blood samples were collected at 0,10,20,30d and analyzed for glucose, urea, total protein, leucocyte count, neutrophil chemotaxis and plasma concentration. Pooled faeces samples were taken from each group at 0, 10, 20, 30d to check the presence of enteropathogenic bacteria. Data were analyzed by ANOVA using the GLM procedure. Feed intake and incidence of diarrhea did not differ among treatments. Enteropathogenic and haemolytic *E. coli* were isolated from all groups, indicating a regular circulation of this opportunistic infection between the pigs. Average daily gain (Cx= 0.529 kg/d, Co= 0.526 kg/d, Ps= 0.521 kg/d) was not affected by the treatments. Plasma glucose, urea and total protein did not differ among the groups. Leucocyte count resulted higher in Ps treatment (18.55x10⁶/ml) than pigs of Cx and Co (Cx=14.61x10⁶/ml, Co=12.38x10⁶/ml). The leucocyte formula did not differ among the groups as neutrophil chemotaxis (Cx=2.01%, Co=2.19%, Ps=2.70%). The results indicate that the phytogen substances may be considered

a valid alternative to the use of carbadox and colistin for postweaning piglets.

Research supported by CNR UCR SISPROAN n.98.02843.CT06 and MURST 60%.

Key Words: Piglets, Weaning, Phytochemical substances

749 Differing patterns of gestation and lactation feed intake on the reproductive performance of gilts and sows. D. Embury¹, S.K. Baidoo², and R. Funk³, ¹University of Manitoba, Winnipeg, ²University of Minnesota, Waseca, ³Landmark Feeds, Landmark, MB.

A 2X2 factorial experiment in a randomized complete block design with 113 total females was conducted to determine the effect of feed intake pattern during gestation and lactation on the reproductive performance of gilts and sows. All diets were based on barley-wheat-soybean meal and exceeded NRC (1988) nutrient requirements for pregnant and lactating sows. The gestation control group (gilts, n=31; sows, n=26) was fed at 1.4 times maintenance requirement d-1 and the pattern fed group (gilts, n=29; sows, n=27) was fed in four stages, 1.1, 1.3, 1.5, and 1.7 times maintenance requirements d-1 on d 1-29, d 30-59, d 60-89, and d 90-until farrowing, respectively. Each gestation group was further divided into two treatments for the 17-d lactation. Control group was 'full-fed' and the pattern group was fed in three stages based on 1.9, 3.0 and 4.1 times maintenance requirements d-1 on d 1 to 6; 7 to 12 and 12 to 17 of lactation respectively. Total feed intake (286.4 vs. 283.5 kg), ultrasonic back fat depths (14.0 vs. 14.5 mm) and live body weight at farrowing, (179.8 vs. 177.9 kg) serum urea nitrogen (15.3 vs. 15.9 mg dl-1) and serum progesterone concentration (15.9 vs. 15.2 ng ml-1) did not differ (P>0.05) between control and pattern fed females during gestation. There was no (P>0.05) effect of gestation treatment on feed intake during subsequent lactation. During lactation, pattern fed females consumed more feed than the control group (4.92 vs. 4.57 kg d-1; P<0.05). Litter size born alive and at weaning were improved (P<0.01) for pattern fed gilts but did not differ (P>0.05) for first parity sows. Pattern fed gilts had a higher number of piglets born alive than control fed gilts (10.33 vs. 9.77 pigs; P<0.01). The results indicate that pattern of feed intake during gestation improved reproductive performance for gilts, but not for first parity sows.

Key Words: Sows, Gestation-lactation, Feedintake

750 The use of Solanum glaucophyllum to improve phosphorus utilization in broilers. Y.-H. Cheng^{*1}, J. P. Goff², J. L. Sell³, S. Gill⁴, E. Pawlak⁴, M. Elena⁴, and R. L. Horst², ¹Iowa State University/Biomedical Science, ²National Animal Disease Center, ³Iowa State University/Animal Science, ⁴CAE, Buenos Aires, Argentina.

The availability of dietary phosphorus can be improved by adding 1,25-dihydroxyvitamin D3 to the diet of broilers. The following experiments were conducted to determine if Solanum glaucophyllum(Sg), a plant containing a glycoside of 1,25-dihydroxyvitamin D3, could be used as a substitute for 1,25-dihydroxyvitamin D3 in corn/soybean meal based diets to improve phosphorus utilization. The basal diet contained 0.6% calcium, 0.5% total phosphorus(0.2% available phosphorus) and adequate vitamin D3. Each treatment was fed to six replicate groups of eight chicks(total of 48 chicks/group) beginning at 8 days of age and continuing until 28 days of age. The treatment diets included the basal diet or basal diet supplemented with either 1,25-dihydroxyvitamin D3 (15ug/kg) or Sg(1, 2.5 or 5.0g/kg diet) and the normal diet (1% calcium and 0.7% total phosphorus). Compared to the basal diet response plasma phosphorus increased in a dose dependent manner with the addition of Sg. Weight gain and tibiae ash were significantly elevated in those animals fed the normal diet as well as those supplemented with 1,25-dihydroxyvitamin D3 and normal diet groups. The results indicated that Sg could be used as a source of 1,25-dihydroxyvitaminD3 for improving phosphorus utilization in chicks. Efforts are being made to identify the glycosides and to determine their relative biological activity in chicks and other species.

Key Words: Solanum glaucophyllum, phosphorus utilization, 1,25-dihydroxyvitamin D3

751 Effect of selection for lean growth efficiency on growth performance, blood profile, and carcass and meat quality. J. Fabian*, L. I. Chiba, D. L. Kuhlers, L. T. Frobish, K. Nadarajah, W. H. McElhenney, J. Lin, and B. L. Anderson, Auburn University, Auburn, AL.

Eight select line (SL) and eight control line (CL) Duroc pigs were used to determine the effects of six generations of selection for lean growth efficiency on growth performance, serum profiles, and carcass and meat quality. At 20 kg BW, pigs were placed in pens individually. Three corn-soybean meal diets [grower (G), finisher 1 (F1), and finisher 2 (F2)] were formulated to meet the NRC nutrient requirements. Pigs were allowed ad libitum access to feed and water. Three blood samples were taken from each pig at 20, 50 and 105 kg BW for glucose, triglyceride (TG), and urea N (BUN) analyses. Pigs were subjected to ultrasound backfat (UBF) measurement at 50 kg BW and at 105 kg BW before slaughter. The SL pigs grew faster and more efficiently (P < 0.05) during the G [ADG: 812 vs 733 g/day; gain to feed ratio (G/F): 429 vs 402 g/kg] and F1 phases (ADG: 931 vs 804 g/day; G/F: 330 vs 296 g/kg), but there was no effect of line during the F2 phase and overall. The SL pigs had lower UBF (P < 0.05) at 50 (7.2 vs 9.0 mm) and 105 kg BW (17.6 vs 22.9 mm), and had higher initial serum TG (54.9 vs 32.3 mg/dL; P < 0.001) and lower initial BUN (9.5 vs 11.7 mg/dL; P < 0.05) than the CL pigs. The SL pigs had heavier heart (342 vs 298 g; P < 0.05), liver (1,459 vs 1,359 g; P = 0.08), and kidneys (298 vs 249 g; P < 0.01). Lower 10th rib backfat (21.7 vs 31.6 mm; P < 0.01) and larger longissimus muscle area (32.8 vs 30.0 cm²; P = 0.1) were reflected in higher estimated daily lean gain (279 vs 238 g/day; P < 0.01) in the SL pigs. The SL pigs had lower meat color (2.02 vs 2.29; P < 0.05), firmness (2.45 vs 3.23; P < 0.01), and marbling (2.82 vs 3.55; P < 0.1) scores. These results indicate that selection for lean growth efficiency has changed the growth rate and body composition of the SL pigs.

Key Words: Pigs, Selection, Lean Growth

752 Bioavailability of phosphorus in high available phosphorus corn and normal corn for young pigs. J. S. Sands* and O. Adeola, Purdue University, West Lafayette, IN.

The bioavailability of phosphorus (P) in high available P (HAP) corn and normal (NORM) corn relative to monosodium phosphate (MSP) for young pigs (avg 9.75 kg) was assessed employing slope-ratio methodology. The experimental design employed was a restricted-randomized block, with 8 dietary treatments, 12 pigs per treatment (6 barrows and 6 gilts), fed for 28 days. A basal diet, composed mainly of cornstarch and soybean meal, containing a total of 2.25 g/kg of P served as the zero supplemental level for both the reference and test diets. The 2 reference and 4 test diets were formulated by adding P as MSP, HAP or NORM at 0.75 g/kg and 1.5 g/kg to the basal diet at the expense of cornstarch. A positive control diet with supplemental amino acids was added to test whether observed responses were due to higher amino acid levels in those diets in which cornstarch was completely replaced by corn. Body weights and feed consumption were recorded weekly and plasma samples taken at d 1 and d 28. Average daily gain and feed intake was greater (P<.05) for pigs consuming HAP corn at the highest supplemental P level. No differences (P>.10) in body weight gain or feed intake were observed between the basal and the positive control diets. Common-intercept, multiple linear regressions in a slope-ratio assay were performed using plasma inorganic P (mg/L) as a dependent variable and supplemental P level (g/kg) and supplemental P intake (g/d) as independent variables. Plasma inorganic P concentration responded linearly (P<.05) to supplemental P intake and supplemental P level. Estimates of P bioavailability from HAP corn and NORM corn based on supplemental P intake were 46 and 33 % respectively. Estimates of P bioavailability from HAP corn and NORM corn based on supplemental P level were 62 and 44 % respectively. The bioavailability of P in HAP corn as estimated by slope-ratio techniques is superior to that of NORM corn.

Key Words: Phosphorus, Bioavailability, High available phosphorus corn

753 Efficacy of DL-methionine and liquid DL-methionine hydroxy analogue (MHA-FA) as methionine sources for pigs. Birgit Schindler^{*1}, Rainer Mosenthin¹, and Meike Rademacher², ¹Hohenheim University, Stuttgart, ²Degussa-Huels AG, Hanau, Germany.

The objective of the study was to determine the efficacy of liquid MHA-FA (88%) compared with DL-methionine (99%) using the N-balance technique in piglets (Piétrain x German Landrace barrows) with an average initial BW of 11.5 kg. A basal diet formulated based on wheat (28.0%), peas (19.0%), barley (15.0%) and tapioca (12.2%) was supplemented with three graded levels of DL-methionine (.025, .050 and .075%) or liquid MHA-FA (.0285, .0570 and .0855%) on equimolar basis. The basal diet contained 18.3% CP, .22% Met and .51% Met+Cys, which is below the methionine requirement according to NRC (1998), but adequate in all other essential nutrients and energy. The trial consisted of two consecutive experiments with 21 piglets each. In total, 6 piglets were randomly allocated to each of seven dietary treatments. The animals were fed twice daily 225 g per meal and had free access to water. They were kept individually in metabolic crates and fitted with adhesive collection bags to the anus that allowed separate quantitative collection of feces and urine. After an adaptation period of 8 d, feces and urine were collected quantitatively over a period of 7 d. The efficacy of the two methionine sources was estimated from nitrogen retention data using an exponential model ($Y = a + b[1 - e^{-(c_1x + c_2x^2)}]$). The efficacy of MHA-FA as compared to DL-methionine was calculated as the ratio of their c-values (c_2/c_1). With increases in dietary methionine, nitrogen retention increased by 33%, which means that efficacy was tested in the sensitive range. Compared with DL-methionine on a weight for weight basis, efficacy of liquid MHA-FA was calculated to be 62%. The results of the present study show a biological effectiveness of liquid MHA-FA in pigs, which is lower than 88% and agrees well with the previous estimates in poultry.

Key Words: Pigs, Methionine sources, Efficacy

754 The effect of enzyme treatment of soybean meal on oligosaccharide disappearance and chick growth performance. K. K. Graham^{*}, J. M. Lynch, and M. S. Kerley, *University of Missouri, Columbia Missouri.*

The oligosaccharides raffinose and stachyose make up about 1.3% and 4.9% of soybean meal, respectively. These two sugars have been shown to be unavailable to many species, including the chick. Gut viscosity is increased in chicks fed soybean meal-based diets causing an increase in passage rate and therefore a decrease in nutrient absorption. Research was done to determine the effects of degrading raffinose and stachyose, using the alpha-galactosidase enzyme, on concentration of these oligosaccharides in feces of chicks fed the enzyme-treated soybean meal (ESBM). Alpha-galactosidase treatment was optimized for oligosaccharide degradation. Enzyme treatment degraded raffinose and stachyose in soybean meal by 84% and 93%, respectively, compared to untreated soybean meal. Diets containing treated soybean meal resulted in excreta raffinose and stachyose concentrations to be reduced to below measurable levels. Enzyme treatment increased ($P < .05$) total metabolizable energy from 2974 to 3328 kcal/g. Two chick growth studies were conducted to determine the effect of feeding ESBM on growth performance. The first experiment showed an increase ($P < .06$) in average daily gain by about 4% in the ESBM compared to the untreated soybean meal. A numerical increase in gain to feed of 1% was also seen in experiment one for the ESBM. The second experiment showed a numerical 3% increase in average daily gain, and an increased gain to feed ratio from .8 to .9. A third experiment was conducted to determine if drying the ESBM in a conventional oven increased monosaccharide concentration, increasing the potential for Maillard products to form. The ESBM showed a stoichiometric increasing of monosaccharides compared to extractable oligosaccharide disappearance. When the treated soybean meal with added lysine was fed to chicks, the average daily gains were the same as the chicks fed the control diet. These experiments demonstrated that feces can be made void of raffinose and stachyose. Soybean meal treated with the alpha galactosidase enzyme may have the potential to increase average daily gain and feed efficiency of chicks.

Key Words: Enzyme, Oligosaccharide, Chick

755 Dietary zinc effects on performance and immune response of growing pigs infected with porcine reproductive and respiratory syndrome virus (PRRSv) and *Mycoplasma hyopneumoniae* (M. hyo). E. Roberts^{*1}, E. van Heugten², G. Almond¹, and J. W. Spears², ¹College of Veterinary Medicine,, ²Department of Animal Science, North Carolina State University.

A 2 X 4 factorial arrangement of treatments was used in a randomized complete block design to determine the effects of dietary zinc (Zn) and PRRSv infection on performance, plasma Zn, alkaline phosphatase activity (ALP), and immune response of pigs exposed to M. hyo (n=72, initial mean BW=26 kg). Factors included 1) intranasal administration of 1 ml PRRSv (10^{3-4} TCID 50, isolate SD 23983), or sham inoculation with media and 2) supplemental Zn at 10, 50, 150 ppm, or added at 2000 ppm for two weeks in the nursery and then supplemented with 150 ppm zinc for the remainder of the trial. Diets were fed beginning in the nursery and continuing into the grower. The corn-soybean based basal diet contained 1% lysine and 34 ppm Zn. Pigs were inoculated with PRRSv on entry into the grower (d 0). Gain, feed intake and gain:feed decreased ($P < .10$) from d 0 to d 31 for pigs infected with PRRSv. Percentage fat free lean was lower ($P < .05$) for control gilts compared to PRRSv infected gilts on d 15. Plasma Zn and ALP increased linearly ($P < .10$) with Zn. PRRSv infection decreased both plasma Zn and ALP ($P < .10$) for d 7 and d 14. A febrile response occurred from d 3 to d 7 and d 26 to d 28 ($P < .10$) for pigs infected with PRRSv. In vivo cellular immune response as measured on d 13 by skin thickness response to phytohemagglutinin was decreased ($P < .10$) after 24 hr for 150 ppm Zn in non-infected pigs. PRRSv or Zn did not affect lymphocyte proliferation. Total antibody response (Ig) to sheep red blood cells was increased ($P < .10$) on d 14 for 150 ppm Zn in control and PRRSv infected pigs. These data suggest that PRRSv and M. hyo act synergistically to produce observed performance deficits and that Zn supplementation in the face of disease is more complex than the conventional view that more is better.

Key Words: Pigs, Zinc, Immune response

756 Biological availability of lysine in wheat for growing pigs. M Cervantes^{*1}, N Torrentera¹, S Espinoza¹, and M Cuca², ¹ICA, Universidad Autonoma de Baja California, Mexicali, ²Colegio de Postgraduados, Montecillos, Edo, Mexico.

Although lysine is the first limiting amino acid in wheat, grain usually provides more than 50% of the lysine requirement for growing pigs. There is limited information on the bioavailability of soft winter wheat. An experiment was conducted with 35 crossbred (Yorkshire-Duroc-Landrace) growing pigs (27.8 avg wt) to determine the bioavailability of lysine in wheat for growing pigs. There were seven treatments with five replicates each. The dietary treatments were: 1) basal, 67% wheat, 30% corn starch; 2) + .05% lys; 3) + .10 lys; 4) + .15% lys; 5) 77% wheat, 20% corn starch; 6) 87% wheat, 10% starch; 7) 97% wheat. Two regression analysis were used to test for linearity; one included treatments 1 to 4, and the other one treatments, 1, 5, 6, and 7. The bioavailability of lysine was determined by single point regression (slope-ratio) techniques, using crystalline lysine (100% availability) as a reference. Daily gain and feed/gain ratio were the criteria upon which lysine availability was based. All diets were deficient in lysine to create a linear response, also all diets were added with .10% threonine. Daily gain and feed/gain were: 127, 254, 381, 556, 185, 382, 506 g/d; 5.23, 3.73, 3.42, 2.83, 5.20, 3.64, 2.88, respectively. There was a linear increase in both, ADG ($r = .99$) and F/G ($r = .96$), as the dietary lysine content was increased either as crystalline lysine or as intact protein. The relative bioavailability of lysine was 73, 79, 91; and 72, 94 and 98%, when ADG and F/G were used as criterion, respectively. The average availability was 81 and 89%, for ADG and F/G, respectively. The wide range of values for lysine availability suggests that threonine was not properly added to diets 4 and 7. These results indicate that lysine is highly available in soft winter wheat for growing pigs.

Key Words: Wheat, Lysine, Bioavailability

757 Ileal amino acid digestibility in pigs fed a wheat based diet added with a fungal protease. M. A. Morales¹, M. Cervantes*², M. Cuca, and N. Torrentera, ¹*Colegio de Postgraduados, 2ICA, Universidad Autonoma de Baja California, Mexico.*

An experiment was conducted to evaluate the effect of adding a fungal protease to a wheat based diet on the apparent ileal amino acid digestibility in growing pigs. Six pigs fitted with a cannula in the terminal ileum (approximately 10 cm from ileo-caecal valve) were used in a two-period, crossover experimental design. A basal, wheat diet supplemented with .55% lysine, .10% threonine, vitamins and minerals was prepared. Treatments were 1) basal diet added without the enzyme, and 2) the basal plus .5% fungal protease. Both diets contained .2% chromic oxide as a digesta marker. The feed was mixed with water at a 1:1 ratio; the enzyme was added when the feed-water mixture was prepared. There were two 11-d experimental periods; each one consisting of 7 days of diet adaptation and 4 days of digesta collection. Ileal samples were continuously collected from 0700 to 1300 h on days 8 and 10, and from 1300 to 1900 h on days 9 and 11. Feed was provided twice daily in equal amounts at 0700 and 1900. The apparent ileal digestibilities (%) of essential amino acids in treatments 1 and 2 were: arginine, 78.7, 79.5; histidine, 78.2, 78.6; isoleucine, 52.2, 53.1; leucine, 66.1, 67.1; lysine, 76.6, 76.9; methionine, 67.1, 67.5; phenylalanine, 66.0, 67.5; threonine, 53.2, 54.0; tyrosine, 72.9, 73.5; valine, 50.4, 52.4, respectively. There was no difference in the apparent ileal digestibility of any amino acid ($P > .10$) in pigs fed either the enzyme-free or the enzyme-added diet. Although the digestibility of two of the most limiting amino acids in wheat appears to be below average, the addition of the enzyme to the diet did not result in any improvement. Thus, from these results it is concluded that the addition of a single fungal protease to a wheat based diet for growing pigs, does not bring any benefit.

Key Words: Pigs, Amino acid digestibility, Fungal protease

758 A comparison of soybean meal versus other protein sources on pork quality. R. M. Strode*¹, M. D. Hemann¹, G. L. Brashear¹, F. K. McKeith¹, M. Ellis¹, J. L. Shelton², L. L. Southern², and T. D. Bidner², ¹*University of Illinois, Urbana, IL,* ²*Louisiana State University Agricultural Center, Baton Rouge, LA.*

Gilts ($n=108$) and barrows ($n=108$) from the Louisiana State University (LSU) and the University of Illinois (UI) were harvested to compare the effect of soybean meal in swine diets, relative to other protein sources, on pork quality. A total of 12 pigs/diet/location were selected from one of nine dietary treatments: SBM= corn soybean meal control, AA= crystalline amino acids, DESB= dry extruded soybean meal, CAN= canola meal, PNT= peanut meal, SFLR= sunflower meal, PEA= ground peas, MBM= meat and bone meal, and PLTY= poultry by-product meal. The diets were formulated to meet or exceed NRC(98) requirements and to have equal Lys:ME ratios. Pigs were killed at approximately 115 kg live weight and the following carcass measurements were taken: color, firmness, marbling, muscle score, L*, a*, b*, 45-minute pH, and drip loss. Ultimate pH, sensory panels, shear force, and proximate analyses were also evaluated. Pigs fed the SBM diet had higher ($P < .10$) subjective color scores than pigs fed other plant source protein diets (DESB, CAN, PNT, and SFLR). Ultimate pH of pigs fed the AA diet was higher ($P < .10$) than pigs fed the SBM diet (5.52 vs 5.43). Pigs fed the SBM diet had more intense ($P < .10$) pork flavor than pigs fed the DESB diet (6.28 vs 7.42, 0= very intense), whereas off-flavor intensity scores from pigs fed the SBM diet indicated less off-flavor ($P < .10$) than pigs from the DESB diet (13.53 vs 11.79, 0=very intense). No differences in sensory tenderness or juiciness were observed between pigs fed the SBM diet and pigs fed the other diets. Pigs fed the SBM diet had less ($P < .10$) intramuscular fat than pigs fed the AA diet or animal protein source (MBM and PLTY) diets. No differences ($P > .10$) were observed between pigs fed the SBM diet and the other diets for L*, a*, b*, drip loss, cook loss, or shear force. Results from this study suggest that dietary protein sources had few consistent effects on pork quality.

Key Words: Soybean Meal, Pork Quality, Protein Sources

759 Ileum and whole-tract digestibility of carbohydrates contained in a corn- or a sorghum-acorn-based diet fed on finishing Landrace and Iberian pigs. J. Morales, J.F. Perez*, M.D. Baucells, and J. Gasa, *Universidad Autonoma de Barcelona, Spain.*

Twenty four finishing pigs (12 Landrace, L; 12 Iberian, I; wt 90.5 kg) were fed *ad libitum* 2 isoenergetic and isoproteic diets based on corn (Diet C; corn grain, 74.9%; soybean meal, 19.7%) or corn, sorghum and acorn (Diet S; corn, 37.2%; sorghum grain, 27.5%; decorticated acorn, 12.5%; soybean meal 19.5%), resulting 4 treatments (6 pigs/each treatment; LC, LS, IC, IS). Cr₂O₃ (0.1%) was incorporated for digestibility measurements. Experimental period lasted approximately 28 days until animals reach an average final wt of 107 kg. At this weight, animals were slaughtered, and ileum and rectum digesta samples obtained and freeze dried. Glucose content in diets C and S were respectively, 62.6% and 57.9% (more than 90% in the starchy fraction). Voluntary intake were significantly higher ($P < 0.01$) on Iberian (3.93 kg/d) than Landrace pigs (3.03 kg/d), not being observed significant differences between diets. Whole tract OM digestibilities (g/kg) determined from rectum digesta Cr contents were significantly different between breeds and diets ($P < 0.01$; 866, LC; 808, LS; 836, IC; 762, IS). Whole-tract digestibility of glucose (g/kg) was also significantly affected by breed and diets, showing a significant interaction ($P < 0.01$; 995, LC; 985, LS; 968, IC; and 937, IS). Differences on the whole-tract digestibility parameters were mainly associated to differences between diets on the ileum digestibility of glucose ($P = 0.06$; 936 vs 843 on diet C and S, respectively) but not differences were observed between breeds ($P = 0.71$; 899 vs 881). Present results suggest a lower hindgut glucose fermentability (g/kg glucose intake) in Iberian than Landrace pigs. Lower fermentability in Iberian pigs could reflect shorter retention times of digesta in the caecum-colon compartment, likely associated with their higher intake. In fact, these differences on fermentability were diet dependent, being Iberian restrictions significantly detected only with diet S.

Key Words: Carbohydrates, Digestibility, Swine

760 Differential action of dietary conjugated linoleic acids (CLA) on lipogenic gene expression in adipose tissue of two porcine genotypes. M.L. Heckart*, J.M. Eggert, A.P. Schinckel, S.E. Mills, and S.S. Donkin, *Purdue University, West Lafayette, IN.*

Conjugated linoleic acids (CLA) when included in the diet for growing pigs decrease lipogenesis and carcass lipid content. A portion of the effect of CLA may involve changes in expression of genes such as Fatty Acid Synthase (FAS) to alter fatty acid synthesis and Stearoyl CoA Desaturase (SCD) to modify the profile of fatty acids in adipose tissue. Furthermore, the response to CLA may vary with genetic propensity for fat accretion. To test these possibilities, eighty pigs from each of two genetic populations characterized by high or average carcass lean (54 versus 52% fat-free lean) were fed a corn and soybean meal diet with the addition of 0 or 0.6% conjugated linoleic acids (CLA) in a 2 x 2 factorial arrangement of treatments. Pigs were serially slaughtered at 23, 46, 68, 91, 114 and 136 kg body weight to obtain subcutaneous adipose tissue for RNA analysis of FAS and SCD. The abundance of FAS mRNA, as determined by Northern blotting, was affected ($P < .01$) by weight, genotype x diet, and genotype x diet x weight. The abundance of FAS mRNA when pigs were fed the control diet was 43% lower for high lean compared to average lean pigs. Feeding CLA decreased expression of FAS in the average lean line and increased ($P < .05$) expression in the high lean pigs. No overall effects were demonstrated for genotype, diet, or diet x weight ($P > .05$). The expression of SCD was responsive ($P < .01$) to genotype, genotype x diet, weight, genotype x weight, diet x weight, and genotype x diet x weight interactions. In control-fed pigs, the abundance of SCD in adipose tissue was 38% lower ($P < .05$) in high lean pigs than in average lean pigs. Feeding CLA decreased ($P < .01$) SCD expression in average lean pigs and tended ($P = .08$) to increase expression in the high lean group. These data suggest that CLA acts to modify expression of lipogenic genes in pigs that are not genetically predisposed to low adipose accretion.

Key Words: CLA, Gene expression, Genotype

761 Potential for an extruded multiple protein complex (Profound™) as a replacement for fish meal in early weaned pig diets. M. E. Davis*¹, D. C. Brown¹, C. V. Maxwell¹, Z. B. Johnson¹, W. R. Walker², and A.K.M.H. Haque³, ¹University of Arkansas, Fayetteville, ²Land O'Lakes, Fort Dodge, IA, ³American Dehydrated Foods, Inc., Springfield, MO.

A total of 216 weaning barrows (20 ± 2 d of age) were used to determine the potential for Profound™ produced using an extrusion process combining liquid egg protein with processed soy protein (Optipro) or soybean meal (SBM) as a replacement for fish meal (FM) in Phase 1 nursery diets. Pigs were transported to an off-site nursery and blocked by weight (6 pigs/pen). Six dietary treatments (6 pens/trt) were fed from d 0 to 10 postweaning and consisted of: 1) a negative control (NC) devoid of FM, 2) the positive control (PC) with 8% FM replacing SBM, 3) the PC with 50% or 4) 100% of FM replaced by Profound™ with Optipro, 5) the PC with 50% or 6) 100% of FM replaced by Profound™ with SBM. Substitutions were made on an equal Lys basis and diets contained 1.6% Lys and 14.7% lactose. A common diet was fed from d 10 to 24 (1.35% Lys) and d 24 to 38 (1.2% Lys) postweaning. From d 0 to 10, pigs fed the PC diet were more efficient ($P \leq .03$) when compared to pigs receiving the NC diet. Average daily gain, ADFI, and gain:feed (G/F) from d 0 to 10, d 10 to 24, d 24 to 38, and d 0 to 38 were similar ($P \geq .10$) among pigs fed the Profound™ diets formulated with either Optipro or SBM (TRT 3 and 4 vs. TRT 5 and 6). Pigs fed either the 50% or 100% replacement of FM with either Profound™ formulated with Optipro or Profound™ formulated with SBM had similar ($P \geq .10$) performance (TRT 3 and 5 vs. TRT 4 and 6). From d 0 to 10, pigs fed the Profound™ diets had similar ($P \geq .10$) ADG, ADFI, and G/F as pigs fed the PC diet (TRT 2 vs. TRT 3, 4, 5, and 6). Pigs previously fed the PC diet had lower ($P \leq .02$) G/F during d 10 to 24 when compared to pigs previously fed the four Profound™ diets (TRT 2 vs. TRT 3, 4, 5, and 6). This study indicates that Profound™ may be effective in replacing 50% or 100% dietary FM in Phase 1 diets. Providing Profound™ in weaning pig diets from d 0 to 10 may improve efficiency from d 10 to 24 postweaning.

Key Words: Swine, Protein source, Egg protein

762 Antioxidant status of puppies as affected by changes in vitamin C, E and iron/copper concentrations. K. Wedekind¹, S. Zicker¹, and D. Jewell*¹, Hills Pet Nutrition, Inc., Topeka, KS.

Numerous studies have demonstrated the benefits of antioxidants in older animals, but few studies have evaluated the efficacy of antioxidants in young growing animals. Vitamin C is clearly an important antioxidant for humans (primates), but its importance in species not requiring vitamin C is not fully known. Commercial petfoods are inherently high in Fe and Cu because of its relatively high meat content, however, excessive iron and copper may negatively affect antioxidant status. Thus it was our objective to determine whether vitamin C and/or E addition was beneficial in puppies and determine if reductions in iron and copper concentrations would improve measures of antioxidant status. Thirty six beagle pups were assigned to a randomized complete block factorial design containing six treatments: 1) an AAFCO-tested Growth control formula, 2) Growth control + 400 IU/kg dl-alpha-tocopherol acetate (E), 3) Growth control + 100 mg/kg ascorbate (Stay-C; (C)), 4) Growth control + E + C, 5) Growth control w/o added Fe and Cu, and 6) Growth control + E + C w/o added Fe and Cu. All diets were fed for 8 wks. The response parameters measured included: serum alpha tocopherol (serum E), oxygen radical absorbing capacity (ORAC), serum chemistry, CBC, and measures of Fe and Cu status (ferritin, TIBC, sera Fe, zinc protoporphyrin, and ceruloplasmin). Significant main effects and interactions ($P < .05$) were observed for both serum E and ORAC. Serum E was higher for pups fed E vs control ($P < .05$), but puppies fed both E and C yielded higher serum E ($P < .05$) than pups fed E only. ORAC was increased for pups fed C or E only relative to control ($P < .05$), but E and C in combination was higher than E or C alone ($P < .05$); reducing Fe and Cu increased ORAC relative to control ($P < .05$), but not relative to pups fed E+C. No differences were observed for measures of iron or copper status. The combination of vitamins C + E was synergistic and improved antioxidant status in puppies relative to E or C alone, but was not further improved by dietary reductions of Fe and Cu.

Key Words: Antioxidants, Puppies, Vitamin E

763 The rat as a model for the assessment of ileal amino acid digestibility of cottonseed meal for pigs. L. Gutierrez*, L. Garcia, F. Vazquez, D. Mendoza, R. Ramos, and B. Saavedra, Center of Research in Food and Development. Hermosillo, Sonora, Mexico.

The use of the laboratory rat as a model animal for the determination of apparent ileal amino acid (AA) digestibility in the growing pig, using the slaughter method, was evaluated. Twenty male Sprague-Dawley rats (190 g body weight) were allotted into two groups and housed individually in stainless steel wire-bottomed cages in a room maintained at 25°C with a 12 h light/dark cycle. Six male hybrid pigs (30 kg body weight) were also housed individually in open pens without bedding material at 25°C. Rats and pigs were fed diets containing cotton seed meal as the sole protein source. Chromic oxide was included in the diets as an indigestible marker. Ileal contents from the terminal 20 cm of ileum were collected after slaughter of the rats and pigs. Ileal and diets samples were analyzed for chromium by atomic absorption and for AA by liquid chromatography. Mean apparent ileal AA digestibility for rats and pigs were, respectively: LYS 45, 45; MET 57, 54; HIS 69, 69; PHE 74, 73; TYR 58, 56; THR 55, 48; LEU 64, 61; ISO 66, 67; ASP 50, 50; SER 59, 59; GLU 75, 72; GLY 48, 54; ALA 56, 57; ARG 85, 84; VAL 66, 67. The data were subjected to a one-way analysis of variance and differences between means were examined using a Tukey-Duncan test. There were no differences for all the AA tested, except for THR, showing that interspecies comparisons made under defined conditions indicated close agreement between rats and pigs for apparent ileal AA digestibility. It is concluded that the growing rat is a satisfactory model for determining ileal AA digestibility in cottonseed meal in the growing pig.

Key Words: Amino acid, Ileal digestibility, Pigs and rats

764 Effects of dietary fat on pork loin quality in heavy pigs. C. Corino¹, V. Bontempo*², G. Pastorelli¹, G. Salvatori², and L. Pantaleo¹, ¹University of Milan, Italy, ²University of Molise, Campobasso, Italy.

A study was conducted to characterize the effect of long term feeding with different fat source on loin quality of heavy pigs. Fifty-four Large White barrows, starting weight 25 kg, were used in a completely randomized block design experiment. Pigs were assigned to three diets providing different supplemental fat: tallow (TA), corn oil (CO) and rapeseed oil (RO). Fats were added at 3% as fed from 25 to 110 kg LW, and 2.5% as fed from 110 kg LW to slaughtering. Diets were fed at 9% BW^{0.75}. Ten pigs of each treatment were slaughtered at 160 kg LW. pH, muscle brightness, and color indexes a* and b* were evaluated at 45 minutes and 24 hrs postmortem on *Longissimus dorsi* muscle using a Chroma Meter CR-300 (Minolta Cameras, OSAKA, Japan). Dry matter content, crude protein, intramuscular fat and the oxidative stability, measured as induced TBA-values, on the same muscle were also evaluated. Data were analyzed by one-way Anova. Differences between treatment means were calculated using the t-Newman-Keuls multiple comparison test. No significant differences were found in growth performances. Dietary treatment did not affect pH, color, dry matter, crude protein and intramuscular fat. Inclusion of CO and RO in the diet reduced the oxidative stability of the pork chops only after 300 minutes of forced oxidation (12.20 vs 14.98 and 14.57 µg MDA/g tissue, SE=.75) ($P < .01$). Fatty acid composition of pork loin was significantly affected only by RO treatment for the C18:3 content (1.05 vs .69 and .64 %, SEM= .07) ($P < .01$). These data suggest that TA, CO, and RO supplement did not have adverse effect on loin quality of heavy pig. Dietary polyunsaturated fatty acids have a small effect on fatty acid content of *Longissimus dorsi* muscle in heavy pig.

Key Words: Heavy pig, Dietary fat, Loin quality

765 Effect of dietary fat on fatty acid composition of backfat in heavy pigs. V. Bontempo*¹, F. Cheli², G. Pastorelli², and C. Corino², ¹University of Molise, Campobasso, Italy, ²University of Milan, Italy.

The experiment evaluated changes in backfat fatty acid composition of pigs fed different fat sources. Fifty-four Large White barrows, averaging 25 kg wt, were allotted within weight to a randomized complete block design. Diets were calculated isoenergetic and with different fat sources: tallow (TA), corn oil (CO), and rapeseed oil (RO). Fats were included into the diet at 3 % as fed from 25 to 110 kg wt, and at 2.5 % from 110

kg to slaughtering. Average weight at slaughter was 160 kg LW. Immediately after slaughtering backfat samples were vacuum-packed, frozen, and stored at -20 C pending analysis for fatty acid content analysis. The pattern of dietary fatty acids was reflected in adipose tissue. Animals fed TA had the highest SFA contents. Animals fed CO had the highest PFA contents and lower MFA contents than TA and RO. Animals fed RO showed the highest C18:3 and C20:1 content. The inner layer of backfat was more saturated than the outer.

Fatty acid %	Dietary effect			Layer effect		SEM
	TA	CO	RO	Outer	Inner	
C14:0	1.44 ^a	1.30 ^b	1.31 ^b	1.36	1.35	.04
C16:0	20.94	20.41	19.68	19.74 ^a	20.95 ^b	.54
C16:1	2.09 ^a	1.69 ^b	1.74 ^b	1.88	1.81	.10
C18:0	13.46 ^a	12.16 ^b	11.68 ^b	11.59 ^A	13.33 ^B	.51
C18:1	44.77 ^A	39.30 ^B	44.29 ^A	43.15	42.78	.82
C18:2	12.17 ^A	19.33 ^B	14.01 ^C	15.52 ^a	14.36 ^b	.48
C18:3	.88 ^A	.85 ^A	1.58 ^B	.97 ^A	1.29 ^B	.12
C20:1	.72 ^A	.80 ^A	1.31 ^B	.98	.78	.08
SFA	35.84 ^A	33.87 ^B	32.67 ^B	32.70 ^A	35.63 ^B	.89
MFA	47.22 ^A	41.43 ^B	46.71 ^A	46.01 ^a	44.60 ^b	.91
PFA	13.05 ^A	20.10 ^B	15.54 ^C	16.49 ^a	15.55 ^b	.49

SFA: saturated fatty acids; MFA: monounsaturated fatty acids; PFA: polyunsaturated fatty acids. ^{AB}P≤.01; ^{ab}P≤.05

Key Words: Heavy pig, Dietary fat, Backfat

766 Effect of dietary glucose phosphate yeast on some blood parameters of stressed gilts. V. Bontempo^{*1}, A. Baldi², L. Rossi², E. Fusi², V. Dell'Orto², and G. Savoini², ¹University of Molise, Campobasso, Italy, ²University of Milan, Italy.

The experiment aimed at evaluating the impact of rapidly available energy sources on postprandial blood parameters in stressed gilts. Three gilts of averaging 30 kg LW, were used in a cross-over design. After an adaptation period of a week to a basal diet (calculated at 2.6 M, where M= 418 KJ ME/P^{0.75}), animals were fasted for 24 h at the end of which they were injected i.m. ACTH solution (5 µg/kg LW). A hour later gilts were fed *ad libitum* one of the following diets: basal diet (C), basal diet plus 50 g of saccharose (S), basal diet plus 20 g of glucose phosphate yeast (GP-Y). Glucose phosphate content in yeast was 30 % on dry matter basis. Blood samples were taken through the jugular vein directly before and subsequently at 0.15, 1.15, 3.15, 5.15, and 7.15 hours after feeding, and analyzed for plasma glucose, NEFA, cholesterol, tryglicerides, protein, urea, GOT concentration. Dietary treatment had no effect on investigated blood parameters. Plasma glucose concentration was significantly influenced by sampling time: gilts supplemented with S and GP-Y showed a lower plasma glucose concentration at 0.15 h than C (9.03 and 9.08 vs 10.85 mM/L, SE= 0.84) (P<0.05). Plasma glucose concentration was greater over the following 7 hours in gilts fed GP-Y than C and S groups, although no significant difference was found. Thus, results suggest that the supply of carbohydrates as sucrose or glucose phosphate may enhance a more rapid utilization of glucose by peripheral tissues in energy deficit and stress conditions. Research supported by CNR UCR SISPROAN n.9802840.CT06 and MURST 60 %

Key Words: Gilts, Glucose phosphate, Blood parameters

767 Efficacy of partially hydrolyzed corn syrup solids as a replacement for lactose in manufactured liquid diets for neonatal pigs. W.T. Oliver^{*}, S.A. Mathews, O. Phillips, E.E. Jones, J. Odle, and R.J. Harrell, North Carolina State University, Raleigh.

Feeding manufactured liquid diets to early-weaned pigs improves growth performance and reduces days to market weight. Few alternative dietary ingredients are utilized other than by-products of the dairy industry, especially for sources of carbohydrates. This experiment was designed to evaluate the efficacy of starch from partially hydrolyzed corn syrup solids (CSS) as a replacement for lactose in manufactured liquid diets. Forty-eight pigs were removed from the sow at one day of age and trained to a liquid feeding system. Pigs were randomly assigned to one of three treatments: 1) control with lactose as the carbohydrate source, 2) lactose replaced with CSS dextrose equivalent (DE) 20, and 3) lactose

replaced with DE-42. Twenty-four pigs were removed from the study on d 10 of treatment and the remaining 24 pigs were removed on d 20 of treatment. Mucosa and intestinal segments were collected from the jejunum and ileum for enzyme analysis and morphological measurements, respectively. Pigs averaged 9.8±2 kg at d 20 of treatment regardless of dietary treatment (P > .20). No differences in ADG, ADFI, or feed efficiency were detected between treatment groups from d 0 to 10 or 0 to 20 (P > .19). Replacement of lactose with CSS did not affect intestinal villi height, width, or crypt depth (P > .10). Pigs fed lactose tended to have greater lactase activity on d 10 than pigs fed CSS (P < .07). Also, pigs fed lactose tended to have lower oligosaccharidase activity than pigs fed the DE-20 diet on d 20 (P < .07). No other differences in lactase, maltase, or oligosaccharidase specific activity on d 10 or 20 of treatment were detected (P > .10). Whole body water, protein, lipid, or ash accretion rates were unaffected by dietary treatment from d 0 to 10 or 0 to 20 (P > .20). These results suggest that partially hydrolyzed CSS can be used as a replacement for lactose in manufactured liquid diets for neonatal pigs.

Key Words: Swine, Neonatal, Carbohydrate

768 The effect of spray-dried animal plasma addition to nursery diets varying in soybean meal concentration. J. Hartke^{*1} and G. Apgar¹, ¹Southern Illinois University, Carbondale.

A total of 180 crossbred pigs (avg 14 +/- 3 d, 4.6 +/- 0.4 kg) were used in two trials to determine if feeding spray dried animal plasma (SDAP) in phase 1 nursery diets with differing soybean meal (SBM) levels can influence performance. Pigs were blocked by initial weight, sex and litter and randomly assigned to one of three treatment diets. All diets were formulated to be equal in lysine concentration and contained 10% dried whey (DW), 10% rolled oats, select menhaden fishmeal, ground corn, and mineral and vitamin supplementation. The dietary treatments were as follows: 1) 10% SBM and 7.5% SDAP, 2) 20% SBM and 7.5% SDAP, and 3) 20% SBM without SDAP. The dietary treatments were fed from d 0-14 post-weaning. A common corn-SBM diet containing 10% DW was fed to all pigs d 14-35 post-weaning. Data from the two trials were analyzed using the GLM procedure of SAS. Contrast statements were used to test differences between treatment means. The testing alpha was adjusted using a Bonferroni procedure in order to maintain a family-wise error rate of .05 (resulting alpha = .017). In trial one, pigs fed either treatment 1 or 2 performed similarly. There were no significant differences in ADG, ADFI, or gain to feed ratios (G:F) days 0-35. Pigs receiving treatment 1 had higher ADG (d 0-21), ADFI (d 0-28), and G:F (d 0-7) than pigs fed treatment 3 (P<.017). Pigs fed treatment 2 had better ADG (d 0-7), ADFI (d 0-21), and G:F (d 0-7) when compared to pigs fed treatment 3 (P<.017). These data suggest that SDAP addition to phase 1 nursery diets greatly improves the pig's ability to utilize SBM. In trial 2, no differences were noted among treatment groups when evaluating ADG or G:F. Pigs fed treatment 1 or 2, however, consumed more feed d 7-14 than pigs fed treatment 3 (P<.017). Because the second trial did not appear to adequately replicate the findings of trial one, a third trial is planned.

Key Words: Nursery pig, Spray-dried Plasma, Soybean Meal

769 Feeding spray-dried plasma decreases the activation of the hypothalamic-pituitary-adrenal axis. K.J. Touchette^{*1}, G.L. Allee¹, R.L. Matteri², C.J. Dyer², and J.A. Carroll², ¹University of Missouri-Columbia, ²Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO 65211.

Previously we reported that pigs fed spray-dried plasma (SDP) have greater hypothalamic-pituitary-adrenal (HPA) axis (i.e., higher serum ACTH and cortisol) and immune (higher serum tumor necrosis factor-α and interferon-γ) responses following a lipopolysaccharide (LPS) challenge than pigs fed a diet with no SDP. The objective of this study was to evaluate mRNA expression of hormones in tissues associated with the HPA axis. Twenty pigs (14 d, 5 kg) were weaned to an isolated environment and allotted to one of four treatments in a 2x2 factorial arrangement, with two levels of SDP (0 vs 7%) and two i.p. injections (LPS vs saline). Both diets were formulated to contain equal ME and digestible essential amino acids and fed for 7 d postweaning. On d 7, i.p. injections of either LPS (150 µg/kg BW) or saline were given. After 3 hr, pigs were sacrificed and tissue was collected for mRNA analysis. Tissue mRNA levels measured were not affected by LPS treatment. Pigs

fed the diet with SDP had a lower level of hypothalamic CRH mRNA compared to pigs fed the diet without SDP ($P < .05$). Pigs fed the diet with SDP also had a lower level of CRH receptor mRNA in the pituitary compared to pigs fed the diet without SDP ($P = .12$). Dietary treatment did not affect POMC mRNA in the pituitary. Pigs fed the diet with SDP had a lower level of adrenal ACTH receptor mRNA compared to pigs fed the diet without SDP ($P < .05$). These results suggest that the HPA axis of pigs fed SDP after weaning may be less activated than that of pigs fed a diet without SDP. Considering the well-known effect of pathogen exposure as a stimulator of the HPA axis, our observation of a lower level of HPA activation may reflect a decreased immune activation as previously reported. Thus, feeding SDP may provide immunological protection for weaned pigs under typical production conditions, and reduce basal activation of the HPA axis.

Key Words: Plasma Protein, Pigs, Stress Response

770 Evaluation of PROTIMAX during various phases of rearing on piglet performance. J.A. Godfredson-Kisic* and T. Shipp, *DuCoa, Highland, IL.*

The effects of PROTIMAX[®], hyperimmunized egg protein, on piglets were evaluated for 5 wk, during various phases of rearing. Crossbred pigs ($n=339$) averaging 6.0 kg were weaned at 28 days and kept in weaner units until 56 days of age. Pigs were randomly assigned to one of 8 treatment diets consisting of 0.1% PROTIMAX[®] (P), or a control (C) diet without P. Treatments were; (1) P, or (2) C diets before weaning 22-28 days of age, (3)P, or (4) C before and after weaning 22-42 days of age, (5) P, or (6) C 22-56 days of age, and (7) P, or (8) C after weaning 29-56 days of age. Diets were equivalent in protein, lysine and macronutrients. Pigs had ad libitum access to feed and water during the trial. Weight and intake were measured weekly, health status was monitored daily. Growth rate of pigs fed P vs. C diets was improved across all treatments, most notably occurring between treatments 3&4 during wk 2 (122.8 g, 110.0 g, $P < .05$), and wk 5 between treatments 5&6 (200.0 g, 172.8 g, $P < .05$). Overall, ADG was greater for piglets fed P than C diets (323.2 g and 311.1 g, $P < 0.01$). Feed conversion was also improved, overall conversion was 1.49 and 1.54 ($P < 0.05$) for P and C. The most dramatic affects of P were on mortality and morbidity. Total mortality for pigs on C diets ranged from 4.6 - 9.8%. Mortality of pigs fed P regardless of phase ranged from 2.3-2.5%. Control group mortality due to diarrhea was 50-74%, which occurred exclusively during 22-35 days of age. There was no mortality due to diarrhea in P fed pigs. Total episode of diarrhea in C pigs was 10.7-15% vs. 1.8-7.1% for P pigs, regardless of phase of supplementation. Duration of diarrhea for P pigs averaged 0.9 days vs. 2.1 days for C. Gain and feed conversion were improved for pigs receiving P, yet dramatic effects were witnessed on overall mortality, mortality due to diarrhea and extent of diarrhea. Profitability can be improved by including hyperimmunized egg protein in the diet during all stages of the rearing period.

Key Words: PROTIMAX, Egg Yolk Antibodies, Piglets

771 Evaluation of ProtiOneTM versus plasma protein for two-week-old weanling pigs. T.E. Shipp* and J.A. Godfredson-Kisic, *DuCoa, Highland, IL.*

The objective of this study was to compare a new proprietary hyperimmunized protein product (ProtiOneTM) with spray dried porcine plasma for early-weaned pigs. ProtiOneTM consists primarily of porcine globulin and hyperimmunized egg proteins. Two hundred crossbred barrows were utilized in a randomized complete block design and assigned to the following treatments: 1) 6% spray dried porcine plasma (C); 2) 4% ProtiOneTM (4PO); 3) 2% ProtiOneTM (2PO); and 4) 2% spray dried porcine plasma (NC). The barrows were blocked according to body-weight and randomly assigned their respective dietary treatments. Diets were equivalent in nutrients and offered *ad libitum* during the trial. Data were recorded for ADG, average daily feed intake (ADFI) and gain to feed (GF) for weeks 1, 2, and overall. During the first week, pigs fed C or 4PO were equal with respect to ADG (0.19 and 0.18 kg/d, respectively) and both C and 4PO grew faster ($P < .05$) than those fed 2PO or NC (0.14 and 0.14 kg/d, respectively). No differences were found for GF during the first week. During the second week, ADG and GF for C, 4PO or 2PO were equal and improved ($P < .05$) over NC fed pigs. Overall, pigs fed C or 4PO were equal with respect to ADG (0.3 and 0.28 kg/d, respectively) and both 4PO and C fed pigs grew faster ($P < .05$) than NC (0.24 kg/d). Overall improvements ($P < .05$) in GF were found

for C and 4PO over pigs fed 2PO or NC (0.7, 0.69, 0.64, and 0.62, respectively). No differences were found for ADFI regardless of period. This study shows that supplementation with 4% ProtiOneTM can offer performance as well as those fed diets supplemented with 6% porcine plasma. Additionally, the lowest inclusion level of porcine plasma does not offer the performance found in higher plasma inclusion rates with two-week-old pigs.

Key Words: pigs, plasma, protein

772 Nitrogen balance of nursery pigs fed different soybean fractions. B.W. Senne*, S.D. Carter, L.A. Pettey, and J.A. Shriver, *Oklahoma State University, Stillwater.*

Eight sets of three littermate barrows weaned at 21 ± 2 d were used to determine N balance of nursery pigs fed different soybean components. Treatments were typical starter diets with either SBM, soy protein concentrate (SPC), or soy protein isolate (SPI) added on an equivalent dig Lys basis. Phase 1 (P1) diets were fed from d 1 to 7 and were formulated to contain 1.26% dig Lys and 3.3 Mcal/kg ME. Phase 2 (P2) diets were fed from d 8 to 21 and were formulated to contain 1.11% dig Lys and 3.3 Mcal/kg ME. Soybean meal, SPC, and SPI, accounted for 22, 21, and 17% of the total P1 diet, and 25, 21, and 18% of the total diet in P2, respectively. Dextrose was used to replace the difference in both phases. Crystalline AA were added as needed to provide an ideal ratio to lysine in all diets. Pigs were housed individually in metabolic chambers to allow for total collection of urine and feces. Rate and efficiency of gain were not affected by treatment. Dry matter excretion as % of intake was similar for all pigs in P1; however, DM digestibility was greater ($P < .07$) for pigs fed SPI compared with pigs fed SBM or SPC in P2. Nitrogen intakes for P1 were 8.7, 8.4, and 10.3 g/d for pigs fed SBM, SPC, and SPI, respectively. Fecal N, urinary N, and total N excretion for the three diets were 1.27, 1.06, and 1.03 g/d; .68, .64, and .88 g/d; and 1.93, 1.69, and 1.92 g/d. Absorption of N as % of intake was lower ($P < .08$) for pigs fed SBM compared with SPI. No differences were detected in retention of N as % of intake. Phase 2 N intakes were 15.1, 15.6, and 16.0 g/d for pigs fed SBM, SPC, and SPI, respectively. Fecal N, urinary N, and total N excretion for the three diets were 1.90, 1.78, and 1.32 g/d; .96, .78, and 1.16 g/d; and 2.86, 2.55, and 2.47 g/d. Pigs fed SPI absorbed more ($P < .05$) N as % of intake compared with pigs fed SBM or SPC. Retention of N as % of intake was similar for pigs fed either SPC or SPI; however, pigs fed SPI retained more ($P < .08$) N compared with pigs fed SBM. These results with nursery pigs suggest that N digestibility improves as refinement of the soybean increases.

Key Words: Pigs, Soybeans, Nitrogen

773 The effect of arginine and glutamine on post-weaning performance and intestinal morphology of pigs. K. J. Touchette*¹, G.L. Allee¹, K. Watanabe², Y. Toride², I. Shinzato², and J.L. Usry³, ¹University of Missouri, Columbia, ²Ajinomoto Co. Inc., ³Heartland Lysine, Inc.

A total of 125 pigs were weaned at 17 d (5.09 kg) to determine the effect of arginine (Arg) and Glutamine (Gln) on nursery performance and intestinal morphology. Pigs were assigned to 1 of 4 treatments with 6 replicates. The positive control contained 7% spray-dried plasma (SDP) with a negative control with no SDP (NP). The other diets contained .6% Arg or 1.2% Gln replacing starch in the NP diet. Diets were fed from d 0 to 14 postweaning. Pigs and feed were weighed on d 0, 7, 14, and 28. Five pigs at weaning (d 0), and one pig from each pen were killed on d 7 and 14 for small intestinal measurements. Villous height (VH), crypt depth (CD), and VH to CD ratio (VCR) were measured. In the 1st wk postweaning, pigs fed Arg had a lower ADG ($P \leq .05$) than pigs fed SDP or Gln, while pigs fed NP had an intermediate ADG. In the 2nd wk postweaning, pigs fed SDP had a higher ($P \leq .05$) ADFI than all other treatments and a higher ($P \leq .05$) ADG than pigs fed Arg, while pigs fed Gln or NP had an intermediate ADG. From d 14 to 28, when pigs were fed a common diet, pigs initially fed Gln had a higher ($P \leq .05$) ADG than pigs fed Arg or SDP, while pigs initially fed NP had an intermediate ADG. Pigs initially fed either SDP or Gln were heavier ($P \leq .10$) than pigs fed Arg on d 28 postweaning, while pigs initially fed NP had an intermediate weight. Pigs at weaning had greater VH, lesser CD, and a higher VCR compared to all pigs on both d 7 and 14 postweaning. Pigs fed SDP had a deeper ($P \leq .05$) CD than all other pigs. Pigs fed SDP had a higher ($P \leq .05$) VCR than pigs fed Arg, while pigs fed Gln or NP had an intermediate VCR. On d 14, pigs fed Gln had a deeper

($P \leq .05$) CD than pigs fed either NP or Arg, while pigs fed SDP had an intermediate CD; VH and VCR were not affected by treatment. These results suggest that .6% Arg is detrimental to nursery pig performance, while 1.2% Gln had positive effects on both performance and intestinal morphology.

Key Words: Glutamine, Intestinal morphology, Piglet

774 Supplemental alpha-lipoic acid and neonatal health and performance in weaned pigs. K.R. Maddock^{*1}, E.P. Berg¹, M.E. Zannelli², L.A. Beausang², C.A. Stahl¹, M.L. Linville¹, and J.A. Carroll³, ¹University of Missouri, Columbia, ²Endogen, Inc., Woburn, MA, ³Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.

The objective of this study was to determine if supplementation of α -lipoic acid (LA) to neonatal pigs has benefits to immune function, feed conversion, and gain. Fourteen weaned gilts (d 21, 7.06 kg) were randomly allotted to two treatments, no LA (CON; n=7) and 56 mg (LA; n=7) of LA/pig/day. The pigs were individually penned and treatments were administered orally for eleven days. Feed intake and body weights were recorded. On d 11, the pigs were nonsurgically fitted with jugular cannulae. On d 12, the pigs received a dose of 150 μ g/kg of lipopolysaccharide (LPS). Blood samples were collected at 15 minute intervals for 30 minutes prior to the LPS challenge and for three hours after to monitor serum concentrations of cortisol, glucose, tumor necrosis factor-alpha (TNF- α), interferon gamma (IFN- γ), % Neutrophils (N), and % Lymphocytes (L). Serum cortisol concentrations showed a time by treatment interaction ($P=0.08$), such that, while serum cortisol increased in both groups between 15 and 135 minutes post LPS, LA pigs showed a less dramatic increase. Serum glucose concentrations showed an overall treatment effect ($P=0.007$) where serum glucose was higher in LA pigs at basal concentrations and throughout the LPS challenge. In both groups, serum glucose concentrations increased between 0 and 90 minutes post LPS, and then decreased for both groups. Percentages of N and L showed a time by treatment effect ($P=0.04$ and $P=0.02$, respectively). Basal %N was 40.9 and decreased in CON post LPS to 14% and increased in LA pigs to 43.25%. Basal %L was 51.9 and increased in CON post LPS to 81% and decreased in LA pigs to 49.25%. LA was shown to help maintain neutrophil and lymphocyte populations following an acute LPS challenge. The present study suggests that LA may be beneficial as a feed supplement to enhance neonatal health.

Key Words: Neonatal Pigs, Alpha-Lipoic Acid, Immune Function

775 Effect of various combinations of copper citrate and copper sulfate on the growth performance of weanling pigs. C. R. Dove^{*} and T. C. Schell, University of Georgia, Tifton.

Two hundred and seventy crossbred pigs (3 trials of 90 pigs, 25+/- 2 days of age, average initial weight 7.64 kg) were used to determine the effects of various combinations of copper citrate and copper sulfate on the growth performance of weanling swine. Pigs were allotted to experimental treatment by weight, sex and ancestry. Pigs were housed in an environmentally controlled nursery (5 pigs/pen) and the number of females and castrated males were consistent within all pens in a replication. Pigs had ad libitum access to feed and water for the 28-day study. Dietary treatments were 1) a negative control, containing 15 ppm of Cu from Cu sulfate; 2) a positive control, containing 250 ppm Cu from Cu sulfate; 3) a diet containing 15 ppm Cu from Cu citrate and 50 ppm Cu from Cu sulfate; 4) a diet containing 15 ppm Cu from Cu citrate and 100 ppm Cu from Cu sulfate; 5) a diet containing 30 ppm Cu from Cu citrate and 50 ppm Cu from Cu sulfate; and 6) a diet containing 30 ppm Cu from Cu citrate and 100 ppm Cu from Cu sulfate. Pigs fed the diets containing all combinations of Cu citrate and Cu sulfate had increased ADG ($P < .05$) compared to the negative control pigs and ADG similar to the positive control pigs. Average daily gains over the 28-day study were 350, 401, 397, 400, 421, 392 g/d for diets 1 through 6 respectively. Over the 28-day study ADFI was increased in pigs receiving diets 3, 4, and 5 compared to pigs receiving both the positive and negative controls ($P < .05$). Gain:feed ratios were improved ($P < .05$) over the 28-day study in pigs fed the positive control diet compared to pigs fed the negative control diet. All other diets had gain:feed ratios similar to the negative controls. These data indicate that combinations of Cu compounds are as effective at stimulating the growth of young pigs as the individual Cu compounds and combinations of Cu compounds can be used at much lower total concentrations of Cu to achieve this growth

response. However, higher concentrations of Cu appear to be needed to improve feed efficiency.

Key Words: Swine, Copper, Nursery

776 Effect of pharmacological ZnO levels in starter pig diets on fecal excretion of Zn. T. A. Meyer^{*}, M. D. Lindemann, and G. L. Cromwell, University of Kentucky, Lexington.

Eighteen weanling crossbred barrows (7.3 kg and 22 d of age) were used in a randomized complete block design to evaluate three levels of supplemental Zn (0, 2000, and 3000 ppm) from ZnO on fecal Zn excretion. All diets contained 150 ppm Zn from the trace mineral mix. Two pigs (balanced for ancestry, weight and age across treatments) were assigned per pen (experimental unit). Pens were modified stainless steel metabolism crates (49 x 37 cm) with a plastic adjustable feeder and a stainless steel nipple waterer. Pigs were fed a complex phase I diet (1.50% lysine) for 1 wk, then a complex phase II diet (1.28% lysine) for 2 wk. Dietary Ca, P and premix concentrations were held constant across treatments and phases. Pigs had ad libitum access to water and feed. Feed wastage was collected daily, and feed intake and growth rate were determined weekly. A total fecal collection was performed with indigo blue marking the beginning and end of each weekly period. Feces were pooled weekly for each pen. Treatment means for ADG, ADFI and F/G (.42 kg, .51 kg, and 1.21, respectively) did not differ ($P > .05$) among treatments. Dietary Zn affected ($P < .01$) the amounts of Zn consumed, apparently absorbed and excreted in the feces. Overall, pigs fed the 2000 and 3000 ppm Zn diets absorbed greater absolute amounts of Zn, and they excreted 14.1 and 21.5 times as much fecal Zn, respectively, as pigs fed the control diet. The following table presents daily Zn intake, excretion and apparent absorption in grams per pig.

Item	Zinc, ppm			SEM	P <
	0	2000	3000		
1 to 7 d					
Zn intake	.043	.474	.613	.035	L .01
Excreted	.028	.362	.468	.033	L .01
Absorbed	.015	.112	.145	.015	L .01
8 to 21 d					
Zn intake	.114	1.531	2.080	.082	L .01
Excreted	.076	1.088	1.704	.056	L .01
Absorbed	.038	.443	.376	.058	L .01; Q .07
1 to 21 d					
Zn intake	.091	1.179	1.592	.063	L .01
Excreted	.060	.846	1.292	.037	L .01
Absorbed	.031	.333	.300	.039	L .01; Q .07

L=linear effect; Q=quadratic effect

Key Words: Feces, Zinc, Pigs

777 Evaluation of conjugated linoleic acid (CLA) and dietary antibiotics as growth promotants in weanling pigs. T. E. Weber^{*}, S. A. DeCamp, K. A. Bowers, C. T. Herr, S. L. Knoll, B. T. Richert, and A. P. Schinckel, Purdue University, West Lafayette, IN.

Weanling pigs (n=192; 28.5 d of age) were randomly assigned to a 2 x 2 factorial arrangement consisting of added dietary fat (1 % of a CLA oil containing 60 % CLA isomers (CLA) or 1 % soybean oil (SBO)) and dietary antibiotic treatment (antibiotics (M) or no antibiotics (NM)). Diets were fed ad libitum for 9 wk in four phases (I, 1; II, 2-3; III, 4-6; IV, 7-9 wk) after which all pigs were fed identical medicated diets for the duration of the finishing stage. M diets contained: phases I and II, 55 mg/kg carbadox; phase III, 299 mg/kg tilmosin; and phase IV, 110 mg tylosin and 110 mg sulfamethazine. Pigs and feeders were weighed at the completion of each dietary phase and prior to moving from the nursery to the grow-finish stage to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). M pigs had higher overall ADG than NM pigs for wk 0-9 (.566 vs. .524 \bar{n} .01 kg/d, $P=.03$). G:F was greater for M pigs than NM pigs during phase I (.356 vs. .277 \bar{n} .02, $P=.03$) and the duration of the nursery stage of the trial (.582 vs. .546 \bar{n} .01, $P=.02$). There were no significant effects of CLA on ADG, ADFI, or G:F. BW were collected at wk 17 post-weaning to determine any residual effects of dietary treatments on finisher ADG (FADG). No significant effects of dietary fat or antibiotic treatments were realized for FADG. Serum samples were harvested from a subset of pigs (n=72)

at the completion of phases II, III, and IV to determine concentrations of IGF-I. There were no significant effects of dietary fat type ($P=.22$) or antibiotics ($P=.27$) on overall serum IGF-I concentrations. However, there was a tendency for M pigs to have greater IGF-I than NM pigs at the completion of phase IV (151 vs. 130 \bar{n} 7.9 ng/mL, $P=.06$). These results demonstrate that .6% added dietary CLA is not effective in enhancing growth performance in weanling swine and that the use of dietary antibiotics can increase production efficiency in nursery pigs.

Key Words: CLA, Antibiotics, Growth

778 Lactitol and tributyrin synergistically prevent the post-weaning syndrome in swine. A. Piva^{*1}, A. Prandini², L. Fiorentini², M. Morlacchini³, F. Galvano⁴, and J. B. Luchansky⁵, ¹Universita' di Bologna, Italy, ²Universita' Cattolica del S. Cuore, Piacenza, Italy, ³CERZOO, Italy, ⁴Universita' di Reggio Calabria, Italy, ⁵USDA, Agricultural Research Service, NAA, ERRC.

The effect of diet on the performance of 64 weaned piglets was monitored for 42 days. At 21 days after birth, the piglets were moved from the piggery to the production barn and fed a medicated diet. At 28 days, the piglets were allotted into the following 4 groups and fed a pelleted feed: 1) control diet (CTR); 2) control diet with tributyrin (TRB; 10 g/kg diet); 3) control diet with lactitol (LCT; 3 g/kg); 4) control diet with a patent-pending nutraceutical containing tributyrin (10 g/kg diet) and lactitol (3 g/kg diet) (TRB+LCT). On days 0, 14, and 42 the animals were weighed, and animal health, feed intake, and FCR were determined. On day 42, the heaviest 2 castrated males and 2 females from each treatment were sacrificed to measure the empty and full weights of the stomach, cecum, and colon, as well as the weights of the liver and kidneys. Additionally the lumen content from the jejunum and cecum were sampled for lactic acid, SCFA, and mono-, di-, and polyamines. Mortality after 42 days ranged from 19% for CTR, to 6% for TRB or LCT, to 0% for TRB+LCT. After 14 days, the ADG was greater (127%; $P<0.05$) in animals fed TRB+LCT compared to CTR or TRB. After 42 days, animals fed TRB+LCT were heavier than animals fed the other diets. At slaughter, no differences in organ weights were observed. With the exception of animals fed LCT wherein cecal lactic acid levels increased 3-fold ($P<0.01$), the concentrations of the organic acids tested were not different among treatments. Moreover, among the various amines analyzed, the only appreciable response ($P<0.05$) was a 66% and 49% decrease in histamine levels in the jejunum and cecum, respectively, in animals fed TRB+LCT. In conclusion, feeding TRB+LCT to stressed piglets was more beneficial than either TRB or LCT alone or the CTR diet for reducing mortality and weight loss and for improving weight gain and health status.

Key Words: additive, histamine, pigs

779 Enteroguard as an alternative feed additive to antibiotics in weanling pig diets. C.M.C. v.d. Peet-Schwering and J.W.G.M. Swinkels, *Research Institute for Pig Husbandry, Rosmalen, The Netherlands.*

In a 39-d 2X2 factorial study, 660 crossbred weaned piglets (BW 8.3 \pm .01 kg; age 26.8 \pm .16 day) were used to examine whether Enteroguard (a combination of freeze-dried garlic and cinnamon oil) is an alternative feed additive to growth promoting antibiotics. The four treatment groups were: (1) no added growth promoting antibiotic and no added Enteroguard, (2) no added growth promoting antibiotic but added Enteroguard (1 kg/tonne), (3) added growth promoting antibiotic (40 mg/kg avilamycin) but no added Enteroguard, (4) added growth promoting antibiotic (40 mg/kg avilamycin) and added Enteroguard (1 kg/ton). All piglets were given free access to feed and water. Piglets were housed in compartments that contained 10 pens (9 or 10 piglets per pen). From d 1 to 15, ADG and G/F were numerically improved with 6.5% and 4.2%, respectively, when Enteroguard was added to the negative control. From d 1 to 39, the addition of Enteroguard to the negative control did not improve the performance of the piglets. Enteroguard does not have an extra benefit in performance when there is already a growth promoting antibiotic in the diet. The addition of avilamycin to the diet improved overall ADG and G/F from d 1 to 39 by 6.1% and .7% with the greatest response occurring during day 1 to 15 (17.9% and 10.8%, respectively). The addition of Enteroguard to the diet reduced the mortality of piglets caused by intestinal disorders from 3.9% to 1.2% ($P<.05$). The number of piglets that received a veterinary treatment was not reduced. The addition of avilamycin to the diet

reduced the number of piglets that required a veterinary treatment for intestinal disorders with 30% ($P<.001$), but it did not reduce mortality. In conclusion, the addition of Enteroguard to weanling pig diets reduces piglet mortality and increases initial performance, although not to the extent of a growth promoting antibiotic.

Group	1	2	3	4	SEM
D 1 to 15					
ADG, g	168	179	198	199	7.7
ADFI, kg	.23	.24	.25	.25	.007
G/F	.69	.72	.77	.77	.017
D 1 to 39					
ADG, g	378	380	401	402	7.7
ADFI, kg	.55	.56	.58	.58	.011
G/F	.69	.68	.69	.70	.009

Key Words: piglets, antibiotics, performance

780 Influence of heat-processing of cereals on performance of piglets. G.G. Mateos^{*1}, E. Gómez², R. Lázaro¹, and P. Medel¹, ¹Dpto Producción Animal, Universidad Politécnica de Madrid, ²Centro de Pruebas de Porcino, Junta de Castilla y León.

A trial was conducted to study the influence of heat-processing (HP) of cereals on productive performance of piglets. There were 8 treatments arranged factorially with 4 cereals (corn, barley, oats and decorticated oats) and two HP (raw vs cooked and flaked). Each treatment was replicated 4 times (12 piglets per replicate). The piglets received their respective experimental diet from 28 to 50 d of age, and then, all of them received a common starter diet until 67 d. From 28 to 50 d, HP improved growth and feed efficiency by 10.6 and 7.8%, respectively ($P<0.01$), and the differences were maintained at 67 d. Piglets fed oats diets grew better and more efficiently than piglets fed corn or barley diets ($P<0.05$). From 50 to 67 d piglets fed corn during the prestarter period grew faster than piglets fed barley ($P<0.05$) but no other differences were found in this period. For the global period (28 to 67 d) HP improved feed intake, growth, and feed conversion by 6.4, 3.6, and 2.7%, respectively ($P<0.05$). Also piglets fed corn grew faster (415 vs 384 g/d) and more efficiently than piglets fed barley (1.43 vs 1.54 g/g; $P<0.01$). There were some interactions between HP and type of cereal for the prestarter and global period; HP improved more piglet performance when fed decorticated oats or barley than when fed corn or whole oats. It is concluded that HP improved performance of piglets from 28 to 50 d of life and that the beneficial effects remained at least up to 67 d of age. Also, HP was more efficient for barley than for corn. The use of oats and HP of cereals for piglets is recommended.

Key Words: Heat processing, Piglets, Cereals

781 Effects of expanding and pelleting diets for finishing pigs fed from wet/dry feeders. N. Amornthawaphat^{*}, J. D. Hancock, K. C. Behnke, R. H. Hine, L. J. McKinney, C. W. Starkey, D. W. Dean, and D. J. Lee, *Kansas State University, Manhattan.*

A total of 208 finishing pigs (average initial BW of 60 kg) were used to determine the effects of expanding and pelleting diets on growth performance, nutrient digestibility, carcass characteristics, and water usage. There were 13 pigs per pen and four pens per treatment. Treatments were: 1) meal; 2) conventional pellets; 3) expanded pellets; and 4) expandate (expanded but unpelleted meal) offered through a single-hole, wet-dry feeder (Crystal Spring[®]). The diets were formulated to .95% and .80% lysine for 60 to 88 and 88 to 113 kg BW, respectively. Pigs fed thermally processed diets (pelleted, expanded-pelleted, and expandate) had 4.4% greater ($P < .04$) ADG, 7.9% greater ($P < .001$) gain/feed, and 3.7 and 4.6% greater digestibilities of DM and N ($P < .001$) compared to pigs fed the meal control. Pigs fed expanded diets (expanded-pelleted and expandate) had 4% greater ($P < .01$) gain/feed than those fed the conventional pellets. Finally, gain/feed in pigs fed expandate was 4.5% greater ($P < .02$) than in pigs fed the expanded-pelleted diet. There were no differences in water usage ($P > .85$) or last rib backfat thickness ($P > .45$) among pigs fed the various dietary treatments. Thermally processed diets (pelleted and expanded) improved growth performance and digestibility of nutrients in finishing pigs fed from wet/dry feeders and, of the thermal treatments, expandate supported the best gain/feed.

	Meal	Standard pellet	Expanded pellet	Expandate	SE
ADG, g	915	960	951	955	15
ADFI, g	2,750	2,745	2,671	2,570	51
G/F, g/kg	333	350	356	372	4
DM dig, %	87.5	91.7	90.6	89.9	.4
N dig, %	84.6	89.2	88.8	87.6	.6
Backfat, mm	23.1	23.7	23.5	25.6	1

Key Words: Wet/dry feeder, Expanding, Pig

782 Effects of soybean genotype and extrusion on digestibility of nutrients and intestinal morphology in nursery pigs. H. Cao*, J. D. Hancock, J. M. DeRouchey, D. J. Lee, N. Amornthwaphat, J. S. Park, R. H. Hines, and W. T. Schapaugh, *Kansas State University, Manhattan.*

A total of 40 weanling pigs (average initial BW of 4.8 kg) were used in a 7-d metabolism experiment to determine the effects of soybean genotype and extrusion on nutrient utilization. All pigs were fed dried skimmed-milk for 2 d post-weaning (to establish feed consumption) and then switched to soy-based experimental diets. A diet was formulated with mill-run, dry-extruded soybeans (DEWS, Insta-Pro 2000, 150°C). The soybeans were the only source of protein and energy in the diet which had 1.05% lysine, .9% Ca, and .8% P and vitamin and mineral supplements to meet NRC recommendations. Genetically modified DEWS replaced mill run DEWS on a wt:wt basis. Treatments were: 1) the mill-run control; 2) low trypsin inhibitor; 3) high protein; 4) low oligosaccharide; and 5) high oleic acid soybeans. The high protein genotype had 39% CP (vs 35% in mill run sorghums). Trypsin inhibitor activity of the low trypsin inhibitor genotype was 19 mg/g fat-free DM (vs 34 mg/g in mill run soybeans) and the low oligosaccharide soybeans had 11.3% sucrose with undetectable amounts (< .01%) of stachyose and raffinose (vs 5% sucrose, 4% stachyose and .7% raffinose in mill run soybeans). Finally, the high oleic acid soybean genotype had 83% oleic acid (vs 36% in mill run soybeans). The processed DEWS had urease activities ranging from .02 to .16 ΔpH, trypsin inhibitor ranging from 3.6 to 5.9 mg/g of fat-free DM, and protein dispersibility index ranging from 8.6 to 13.9% when fed to pigs, there were no differences among the DEWS diets for ME, apparent digestibilities of C16:0 and C18:1 (P > .13). The pigs fed mill run soybeans had longer villi (P < .09) but similar villi height: crypt depth ratios and serum HDL:LDL compared to modified soybeans (P > .13). Pigs fed low oligosaccharide and high oleic acid soybeans had greater (P < .08) pancreatic chymotrypsin activity than those fed low trypsin inhibitor and high protein soybeans but lower mucosal amylase activity (P < .07). Our data indicated that different soybean genotypes did affect enzyme secretion and intestinal morphology, but had little effect on digestibility of nutrients.

Key Words: Nursery pigs, soybean genotype, extrusion

783 Effects of feed- and food-quality sorghums on milling characteristics and growth performance in nursery pigs. C. L. Jones*, J. D. Hancock, C. M. Sowder, L. J. McKinney, D. W. Dean, D. J. Lee, J. S. Park, and N. Amornthwaphat, *Kansas State University, Manhattan.*

A total of 192 weanling pigs (average initial BW of 6.8 kg) were used to determine the effects of identity-preserved sorghums on milling characteristics and growth performance. Treatments were mill-run corn and sorghum and identity preserved bronze seed/purple glume (feed quality, Asgrow A570) and white seed/tan glume (food quality, Asgrow 6126) sorghums. The corn was ground through a hammermill (1.6 mm screen openings) and used in diets formulated to 1.7, 1.55, and 1.4% lysine for d 0 to 7, 7 to 21, and 21 to 35, respectively. The sorghums were ground through the same hammermill screen and substituted for corn on a wt/wt basis. No differences in net grinding energy or production rate were observed among corn and the sorghums (P > .50). However, true grinding efficiency (surface area generated per Wh of energy input) was greater for the sorghums than corn (P < .01) mill-run sorghum required less energy to grind than the identity preserved sorghums (P < .003). Finally, the bronze sorghum tended to grind easier (P < .06) and with greater production rates (P < .03), and resulted in diets having greater pellet durability index (P < .03), than the white sorghum. In the pig feeding experiment, there were no differences in ADG or gain/feed among pigs fed corn- vs sorghum-based diets (P > .13). Also, there were

no differences in growth performance of pigs fed mill-run vs identity-preserved sorghums (P > .26) or the bronze vs white sorghum (P > .33). In conclusion, mill-run sorghum ground easier than the identity-preserved sorghums but there were no differences in growth performance among pigs fed the various cereal grains.

Item	Mill-run		Bronze seed/ purple glume	White seed/ tan glume	SE
	Corn	sorghum			
Production rate, t/h	2.52	2.39	2.83	2.26	.04
Net energy, kWh/t	7.9	6.8	8.1	8.8	.2
True efficiency, m ² /Wh	1.4	2.2	1.3	1.3	.1
Pellet durability, %	83.5	84.1	84.0	82.1	.5
ADG, g	486	503	508	501	10
ADFI, g	599	626	627	604	16
Gain/feed, g/kg	812	804	815	832	14

Key Words: Sorghum, Food-quality, Pig

784 Comparative DE values of wheat, corn, soybean and their by-products in growing pigs and adult sows. J. Noblet* and G. Le Goff, *INRA, Saint Gilles, France.*

The DE values of wheat and wheat by-products (W; n=9), corn and corn by-products (C; n = 9) and soybean products (SB; n = 7) were measured in 65-kg growing pigs (G) and adult non-pregnant, non-lactating sows (S). Three, one and four ingredients were wheat, corn and soybean meal (SBM) in the W, C and SB groups, respectively. The other SB ingredients were soybean hulls (SBH; n = 1) and combinations of SBM and SBH. The W and C by-products originated from milling or starch extraction industries. Relative to DM, W and C ingredients differed in starch (70 to 19% and 74 to 23%, respectively) and NDF (12 to 50% and 12 to 58%, respectively) contents; average starch contents of wheat and corn were 70 and 74%, respectively. The SB ingredients varied in CP (11% to 54%; 51% on average for SBM) and NDF (62% to 9%; 13% on average for SBM) contents. The ingredients were fed as a single ingredient or combined with a basal diet at about 2.0 and 2.4 kg/d for G and S, respectively. Each feed was given to at least four animals of each physiological stage. Excreta were collected for 10-d. The DE values (MJ/kg DM) of all ingredients were higher in S than in G and averaged 14.1 and 14.8 for W ingredients (16.2 and 16.4 for wheat), 13.0 and 15.1 for C ingredients (16.7 and 17.4 for corn) and 15.0 and 16.6 for SB ingredients (17.0 and 17.8 for SBM) in G and S, respectively. The DE value decreased as the dietary fiber (DF) content increased (minus 15.0, 14.9 and 16.9 kJ/g additional NDF in G and minus 12.9, 7.3 and 10.1 kJ/g NDF in S for W, C and SB ingredients, respectively). Consequently, the difference in DE value between S and G was linearly related to the DF level of the feed and varied by 2.5, 5.7 and 6.5 kJ for each additional g of NDF in W, C and SB groups, respectively. The results demonstrate that different DE values should be used for G and S; the difference between values depends on the amount of DF and its botanical origin (i.e., the chemical characteristics of DF). Further information is required to take into account changes in gas and heat losses associated with the higher rate of fermentation of DF in adult pigs.

Key Words: Energy Value, Growing Pig, Adult Sow

785 Apparent ileal amino acid digestibilities of corn distiller's dried grains with solubles produced from new ethanol plants in Minnesota and South Dakota. M. H. Whitney¹, M. J. Spiels^{*1}, G. C. Shurson¹, and S. K. Baidoo², ¹University of Minnesota, St. Paul, ²University of Minnesota, Waseca.

Two studies were conducted to determine the apparent ileal amino acid (AA) digestibilities of corn distiller's dried grains with solubles (DDGS) produced from newer (< 5 yrs old) ethanol plants in Minnesota and South Dakota (MNSD), and compare these to values for DDGS originating from an older Midwestern plant (OMP). In experiment 1, eight crossbred pigs averaging 38.8 kg initial body wt were surgically fitted with a simple T-cannula, inserted at the ileal-cecal junction. After a 14 d recovery period, pigs were allotted to experimental diets in a latin square

design. Pigs were limit fed (approximately 75% ad lib) each of four experimental diets: control containing 90% corn-soybean meal (CSBM), 30% MNSD-60%CSBM, 60% MNSD-30%CSBM, and 90% MNSD. The remaining 10% of each diet contained supplemental vitamins and minerals to meet or exceed NRC (1998) requirements. Pigs were allowed a 9-d adjustment period, followed by a 2-d digesta collection period (12 hr/d) in each of four consecutive 11-d feeding periods. Samples were immediately frozen for subsequent AA analysis. Apparent ileal Lys, Met, Thr, and Trp digestibility coefficients of MNSD were 53.6, 58.5, 55.2, and 63.6%, resulting in apparent digestible AA levels of .44, .32, .62, and .15%, respectively. Immediately following experiment 1, pigs were allotted to one of two dietary DDGS treatments (90% MNSD or 90% OMP) for two collection periods. Pigs fed the MNSD DDGS diet had greater ileal Lys (47.4 vs -3.8%, $P < .01$), Met (65.8 vs 48.5%, $P < .02$), and Thr (59.9 vs 36.5%, $P < .01$) digestibility coefficients compared to OMP DDGS, but there were no differences between sources for Trp digestibility (67.4 vs 68.3%, $P > .10$). Results from these studies suggest that apparent ileal AA digestibility of MNSD DDGS is superior to OMP DDGS, and higher than published NRC (1998) values. Knowledge of apparent AA digestibilities will allow more effective use of MNSD DDGS in swine diets.

Key Words: Pigs, Distiller's dried grains with solubles, Apparent amino acid digestibility

786 Determination of the metabolizable energy concentration of three corn hybrids fed to growing pigs. R.W. Fent*, S.D. Carter, B.W. Senne, and M.J. Rincker, *Oklahoma State University, Stillwater.*

Eight sets of three littermate barrows (initial wt = 25.6 kg) were utilized to determine the ME concentration of three commercially available corn hybrids. The hybrids (A, B, and C) were grown in the same location during the same year, and they were ground to a common particle size prior to mixing the experimental diets. The experimental diets (A, B, and C; 1.0% Lys) consisted of each corn hybrid (90.48%) supplemented with casein (5.04%), crystalline AA, and mineral and vitamin sources. Pigs were housed individually in metabolism chambers and equally fed within replicate. Pigs were allowed a 7-d adjustment period to the diets followed by a 5-d collection of feces and urine. All data are reported on a DM basis unless otherwise noted. The GE concentrations (kcal/kg) of Hybrids A and B were similar (4,349 and 4,323), but was greater for Hybrid C (4,467). The GE of the experimental diets were 4,306, 4,317, and 4,337 kcal/kg, respectively. Fecal GE excretion tended to be greater ($P < .11$) for Diet C vs Diets A and B. Digestible energy for Diets A, B, and C were 3,884, 3,909, and 3,836 kcal/kg, which resulted in DE:GE of .902, .906, and .885, respectively. Urinary energy excretion was similar among treatments. The ME concentrations of the 3 diets were 3,811, 3,838, and 3,773 kcal/kg and ME:GE was .885, .889, and .870. The ME concentrations of the three diets were similar, but ME:GE tended to be lower ($P < .14$) for Diet C as compared with Diets A and B. To approximate the ME concentration of each corn hybrid, the ME provided by casein was subtracted from the ME of each experimental diet. As a result, GE and ME, on an as-fed basis, were, 3,858 and 3,523; 3,846 and 3,560; and 3,971 and 3,493 kcal/kg for Hybrids A, B, and C, respectively. Thus, ME:GE was .913, .926, and .879. These results suggest only minor differences in ME content of three corn hybrids grown in one location during the same year. However, based on these data, GE of corn is not indicative of the ME concentration as the ME:GE ratios varied with corn hybrid.

Key Words: Corn, Metabolizable energy, Pigs

787 A biochemical model of nutrient utilization in growing pigs. J. van Milgen* and J. Noblet, *INRA, Saint-Gilles, France.*

A mathematical model was developed that allows calculation of the biochemical efficiency of nutrient utilization in growing pigs. The model is based on a number of intermediates and cofactors that are involved in the metabolism of amino acids and carbon chains. These intermediates include glucose, pyruvate, acetylCoA, α -ketoglutarate, oxaloacetate and serine. Degradation of dietary amino acids and synthesis of non-essential amino acids can be expressed as a function of these intermediates and cofactors. Excess intermediates (both from protein and starch) yield acetylCoA, which can be used for ATP or lipid synthesis. The calculated efficiency of glucose for lipid synthesis was 83%. Based

on the body amino acid composition and assuming that 5 ATP are used per peptide bond, the calculated energetic efficiency of protein synthesis is 86%. This value is much higher than experimental values (approximately 0.60). However, the former calculation assumes that amino acids are directly used for protein synthesis (i.e., protein turnover is not considered). Using three protein turnover cycles (i.e., four times formation and three times hydrolysis of the peptide bond), the efficiency reduces to 61%. Amino acids differ largely in the efficiency with which they can be used for ATP (or lipid) synthesis. The ME/DE ratio ranges from 0.66 (arginine) to 0.93 (tyrosine and phenylalanine). The NE/ME ratio ranges from 0.62 (cysteine) to 0.96 (glutamate). If dietary amino acids are incorporated into protein before being catabolized (e.g., through stimulation of endogenous secretions or protein turnover), the NE/ME ratio drops rapidly ranging from 0.23 (glycine) to 0.83 (isoleucine). Viscera catabolize large quantities of dietary glutamate and glutamine, and synthesis of these amino acids (e.g., from glucose) is required for protein deposition. The efficiency of this scenario is relatively high (95% for glutamate and 92% for glutamine) and is similar to the temporary storage of glucose as glycogen (95-97%). Energy losses that occur in the transformation of nutrients for ATP synthesis and lipid deposition seem to be mainly of biochemical origin. Other processes (e.g., turnover or biophysics) may play a major role in the energetic efficiency of protein deposition.

Key Words: Mathematical Model, Energy Metabolism, Protein Metabolism

788 Utilization of low heat increment diets at high ambient temperatures in growing pigs. L. Le Bellego¹, J. Van Milgen¹, M. Rademacher², S. Van Cauwenberghes³, and J. Noblet*¹, ¹INRA, Saint Gilles, France, ²Degussa-Hls, Hanau, Germany, ³Eurolysine, Paris, France.

Sixty-four barrows were used to study the effect of using diets with a low heat increment (HI) at thermoneutral (22 C) and high (29 C) ambient temperatures on growth performance. For each dietary treatment, two diets providing 0.85 and 0.70 g of digestible lysine per MJ NE were prepared for the growing (30 to 65 kg) and finishing periods (65 to 100 kg), respectively. A reduction in HI was achieved by partial replacement of soybean meal in a wheat - corn - soybean diet (NP diet) by wheat and corn (LP diet), or by wheat, corn and 4% fat (LPF diet). The CP levels were 19.7, 15.3, 16.4% for the growing period and 17.5, 12.5, 13.3% for the finishing period for the NP, LP and LPF diets, respectively. Industrial amino acids were used to maintain an optimal and balanced amino acids supply. Pigs were penned individually with ad libitum access to feed and were slaughtered at 100 kg. Increase of ambient temperature from 22 to 29 C resulted in marked reductions of ADFI (15%), ADG (13%) and body fatness (22.8 vs 24.8% fat tissues in carcass). At 22 C, ADFI (g/d) was higher for the NP (2752) than for the LP (2575) and LPF (2544) diets but NE intakes were similar (27.8 MJ/d), as were ADG (1080 g/d) and carcass composition (24.8% fat). At 29C, ADFI values were not different (2265, 2243 and 2202 g/d for NP, LP, and LPF diets, respectively) and NE intake (MJ/d) was higher for LPF (24.5) than for the NP (23.2); it was intermediate for LP diet (23.6). Despite differences in NE intakes at 29 C, ADG were similar (934 g/d) and pigs tended to be fatter with the LP and LPF diets (23.1 and 23.3% fat) than for the NP diet (22.0%). The feed to gain ratio was not affected by temperature or dietary treatment (25.7 MJ NE/kg on average). These results confirm that at optimal amino acid supplies, CP can be reduced without negative effect on performance of growing-finishing pigs. The additional NE intake of the low HI diets at high ambient temperature results mainly in fat tissue gain.

Key Words: Growing Pig, Heat Increment, High Temperature

789 Effects of the addition of *Yucca schidigera* extract and an acidified diet on reducing ammonia emission in nursery pig facilities. J. J. Colina*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

Three trials were conducted to determine the effects of the addition of *Yucca schidigera* extract or calcium chloride to the diet on ammonia emission and growth performance in nursery pigs weaned between 11 and 15 d of age (initial body weight of 3 to 5 kg). In Trial 1, 90 cross-bred barrows were allotted by weight to three identical, environmentally controlled rooms (6 pigs per pen, 30 pigs per room). In each room, relative humidity, temperature, and ventilation were maintained constant.

In Trials 2 and 3, 150 crossbred pigs were used (10 pigs per pen, 50 pigs per room). Pigs were fed one of three diets: 1) Control, containing 23% CP; 2) Control diet plus 125 ppm of *Yucca schidigera* extract (30%); and 3) Control diet plus 1.95% calcium chloride. Each trial consisted of a 1-wk adaptation period (during which a common diet was fed) and a 3-wk experimental period (during which the experimental diets were fed). Average daily gain, ADFI, and ADG/ADFI were recorded weekly. Aerial ammonia was measured daily using detector tubes. Manure samples from the pit in each room were taken on d 4, 7, 11, 14, 18, and 21. Ammonia concentration in manure samples was measured using an ammonia-gas detecting electrode. An electronic pH meter was used to measure manure pH. Data were analyzed using a linear model with trial as a block and week as a repeated measurement. There were no differences in ADG, ADFI, or ADG/ADFI ($P > .5$) between pigs fed the control diet and pigs fed the *Yucca schidigera* diet. Pigs fed the calcium chloride diet had lower ADG, ADFI, and ADG/ADFI than pigs fed the other two diets ($P < .001$). Aerial ammonia concentrations were greater ($P < .001$) in rooms in which pigs were fed the control diet than in rooms in which the other two diets were fed. Manure ammonia and pH did not differ among diets. Although ammonia concentrations were relatively low in these trials, both the addition of *Yucca schidigera* extract and calcium chloride to diets of nursery pigs seemed to reduce ammonia emission.

Key Words: Pigs, Ammonia, Growth

790 Diet modification to reduce odorous compounds in pig manure. S. Hankins^{*1}, A. Sutton¹, J. Patterson¹, O. Adeola¹, B. Richert¹, A. Heber¹, D. Kelly¹, and K. Kephart², ¹Purdue University, West Lafayette, IN, ²Pennsylvania State University, University Park.

Three replicate 4 X 4 Latin square trials were conducted with cecal cannulated grow-finish crossbred gilts to determine the effects of amino acid supplementation, fiber and anthraquinone (Anth) additions to the diet on production of odorous compounds from cecal contents, fresh manure and stored manure. Corn-soy diets fed were Diet I; a 13% crude protein (CP) corn-soy diet with total Lys, 0.61%; total Met+ Cys, 0.47%; total Trp, 0.12%; total Thr, 0.39%; Diet II; a 10% CP corn-soy diet with crystalline amino acids, 0.36% Lys (0.6% total Lys), 0.0% Met (0.40% total Met+Cys), 0.02% Trp (0.10% total Trp) and 0.1% Thr (0.40% total Thr); Diet III; Diet II with 5% cellulose and, Diet IV; Diet I with 0.1% Anth. Pigs were ad libitum fed. Reducing the CP from 13% to 10% and adding cellulose reduced pH in stored manure by .6 and .8 units ($P < .05$), respectively. Total nitrogen content in fresh manure was reduced 33% by reduced CP and 48% with reduced CP and added cellulose ($P < .05$). The lower stored manure pH and total N was partially due to a .8 - .9 unit ($P < .05$) decrease in urine pH and a 21 - 22% ($P < .05$) decrease in total urinary N content. Ammonium and total N were reduced 75% and 60% ($P < .05$), respectively, in stored manure when the reduced CP diet also contained cellulose, compared to the 13% CP diet. Total VFA in stored manure were reduced 41% ($P < .05$) with the reduced protein diets and 83% ($P < .05$) with added cellulose compared to the 13% CP diet. Lower CP diets that were supplemented with synthetic amino acids and cellulose showed a numerical decrease in sulfide and phenolic compounds in fresh and stored manure compared to the 13% CP diet. Addition of Anth to the standard diet numerically decreased carbon disulfide, hexane, and 2-butanone in stored manure and phenolic compounds in freshly excreted manure compared to manure from pigs fed the control diet. However, numerically higher levels of volatile sulfide compounds were noted in stored manure from pigs fed Anth. Although there is evidence that Anth might reduce certain volatile organic compounds, Anth's effectiveness in controlling sulfur containing odors needs further experimentation. Reducing dietary amino acid excesses significantly reduced odorous compounds and this reduction was further enhanced by the addition of 5% cellulose to the reduced CP diet.

Key Words: Pigs, Manure, Odors

791 Effects of dietary supplementation of exogenous fibers on ammonia and hydrogen sulfide emission from growing-finishing pigs fed corn and soybean meal-based diets. Y. Gao^{*1}, T. Rideout¹, D. Lackeyram¹, T. Archbold¹, M. Z. Fan¹, E. J. Squires¹, C. F. M. de Lange¹, T. K. Smith¹, and G. Duns¹, ¹University of Guelph, Ontario, Canada.

A trial was conducted to examine the effects of dietary supplementation of exogenous fibers on ammonia and hydrogen sulfide emission from swine slurry. Five Yorkshire barrows, initial weight of 25 kg, were fed five diets according to a 5 x 5 Latin square design with five experimental periods. The diets were corn and soybean meal-based, contained the same amount of protein and amino acids and differed in the source and levels of fibers. Diet 1 had no extra fiber and served as the control; diets 2 and 3 were with 4.5 and 9.0% of apple pectin; diets 4 and 5 were with 4.5 and 9.0% of cellulose, respectively. Each period lasted for 14 days with 10-d adaptation followed by 4-d collection of feces and urine. For each period, fresh manure slurry was made by mixing the collected fresh feces with urine at a ratio of 1: 2.5 (wt/wt). Accumulative ammonia and hydrogen sulfide emission from the slurry of different dietary treatment conditions was measured with our recently established trapping system at different time points (0, 24, 30, 54, 78 and 102 h, respectively) at the room temperature. Inclusion of apple pectin at the level of 4.5% decreased the 102-h accumulative NH₃ emission by 35.7% (9.9 vs. 15.4 g NH₃/kg DM slurry) in comparison with the control diet. Furthermore, adding apple pectin at the levels of 4.5 and 9.0% also decreased the 102-h accumulative H₂S emission by 12.9 and 56.7%, respectively (2.6 and 1.3 vs. 3.0 g H₂S/kg DM slurry) in comparison with the control diet. However, cellulose tended to have less effects on both NH₃ and H₂S emission. In conclusion, dietary supplementation of exogenous water-soluble fiber such as pectin is effective to reduce ammonia and hydrogen sulfide emission related pollution to the environment.

Key Words: Fiber, Ammonia and hydrogen sulfide emission, Pigs

792 Lipogenic enzyme activities in adipose and muscular tissues of Landrace and Iberian pigs fed on different sources of carbohydrates. J. Morales¹, J.F. Perez^{*1}, J. Mourou², M.D. Baucells¹, and J. Gasa¹, ¹Universidad Autonoma de Barcelona, Spain, ²INRA, St-Gilles, France.

Iberian is swine breed from Southwest Iberian Peninsula traditionally fattened in an extensive production system. Iberian meat and meat products have attained a high acceptability, generally attributed to a higher marbling. The present study explores the lipogenic enzyme activities of Landrace and Iberian finishing pigs with different depositions. Twelve Landrace and 12 Iberian pigs were grown on two diets based on corn (diet C) or sorghum and acorns (diet S). No differences were observed in the average daily gain (767 g/day). At 107 kg wt animals were slaughtered and samples obtained from backfat (SC), intermuscular fat (IM) and glutens medium (GM), immediately frozen in liquid N₂ and stored at -80C until analyses of lipogenic enzyme activities (acetyl-CoA-carboxylase, ACX; malic enzyme, ME; and glucose-6-phosphate-dehydrogenase, G6PDH; nM/g x min). The activities of all enzymes were lower in GM than SC and IM fat, especially of G6PDH. No significant differences were observed between breeds or diets on the ACX activities in the SC (1.53) and GM (0.51), but were lower ($P < 0.01$) in the IM fat of Iberian pigs (0.61) vs Landrace (1.45). Malic enzyme and G6PDH activity was significantly higher in Iberian than Landrace pigs in SC fat (34.3 vs 21.5, ME; 14.8 vs 10.6, G6PDH) and GM muscle (5.35 vs 2.93, ME; 0.52 vs 0.38, G6PDH). Experimental diets (diet C and S) did not promoted significant differences on the ME and G6PDH activity of different tissues, except on Iberian pigs which showed higher activities with diet C than S, in SC ($P = 0.21$) and IM fat (22.5 vs 10.5, ME; 10.5 vs 5.6, G6PDH; $P < 0.05$). Significant differences between breeds were modulated by dietary characteristics, encouraging further studies on the metabolic effects of nutrients absorbed.

Key Words: Lipogenesis, Breed, Swine

793 Soybean meal versus other protein sources on growth and carcass traits of swine. J. L. Shelton^{*1}, R. M. Strode², M. D. Hemann², G. L. Brashear², F. K. McKeith², M. Ellis², L. L. Southern¹, and T. D. Bidner¹, ¹Louisiana State University Agricultural Center, ²University of Illinois, Urbana.

Gilts (n=200) and barrows (n=200) from the Louisiana State University (LSU) Agricultural Center and the University of Illinois (UI) were used to compare the effect of soybean meal in swine diets, relative to other protein sources, on growth performance and carcass traits of growing-finishing pigs. A total of 20 pigs/diet/location were allotted to nine dietary treatments: SBM= corn soybean meal control, AA= crystalline amino acids, DESB= dry extruded soybean meal, CAN= canola meal, PNT= peanut meal, SFLR= sunflower meal, PEA= ground peas, MBM= meat and bone meal, and PLTY= poultry by-product meal. The diets were formulated to meet or exceed NRC (98) requirements and to have equal Lys:ME according to dietary phase and sex. Pigs (12/pigs/diet/location) were killed at a BW of 115 kg in the LSU and UI Meat Science Laboratories. Pigs fed SBM had an increased (P < 0.04) ADG relative to pigs fed the AA, plant sources (DESB, CAN, PNT, and SFLR), or animal sources (MBM and PLTY) of protein and an increased (P < 0.02) ADFI relative to pigs fed the AA, DESB, or the animal sources. Feed efficiency was decreased (P < 0.05) in pigs fed AA but increased (P < 0.05) in pigs fed DESB compared with SBM. Loin muscle area was increased (P < 0.01) in pigs fed SBM compared with pigs fed the AA diet. Tenth rib backfat thickness was decreased (P < 0.09) in pigs fed SBM relative to those fed AA, peas, or animal sources of protein. Percentage muscling was decreased (P < 0.09) in pigs fed AA, peas, or the animal sources of protein, and kilograms of lean was decreased (P < 0.05) in pigs fed AA or peas relative to SBM. Visual muscle scores were increased (P < 0.09) in pigs fed diets with SBM relative to pigs fed any other protein source. Results from this experiment suggest that pigs fed SBM have equal or better growth performance and carcass traits than pigs fed other protein sources.

Key Words: Soybean Meal, Carcass Traits, Protein Sources

794 The use of near infrared spectroscopy and in vitro methods to predict the digestibility of compounded pig diets. J.V. O' Doherty^{*}, M.G. Dore, and F.P. O' Mara, *University College Dublin, Ireland.*

In vivo digestibility trials with 82 concentrates containing widely diversified feed ingredients were carried out in grower-finisher pigs to calibrate and evaluate near infrared spectroscopy (NIRS) and in vitro digestibility techniques for the prediction of nutrient digestibility and digestible energy (DE) content of pig feedstuffs. The feed samples were initially analysed for dry matter (DM), gross energy (GE), crude protein (CP), crude fibre (CF), ether extract (EE), ash and neutral detergent fibre (NDF). The predicted DE content of the diets was estimated using the in vitro (EFOS) technique. Two different subsamples of each sample were scanned over the near infrared spectrum, 1100 to 2500 nm at 2 nm intervals. Equations to predict DE and the digestibility of the organic matter (OM), energy and nitrogen (N) were calibrated and validated using 3 mathematical regression models; Principal Component Regression (PCR), Partial Least Squares (PLS) and Modified Partial Least Squares (MPLS). The relationship between in vivo DE and in vitro DE resulted in the prediction equation: $DE = 5.22 + 0.638 \times EFOS$ (RSD = 0.416; $R^2 = 0.85$; mean DE = 13.85 MJ/kg). The prediction equation of DE from the in vitro DE and the chemical composition gave $DE = -4.45 + 0.229 \times EFOS - 0.023 \times CP - 0.088 \times Ash - 0.138 \times EE - 0.045 \times NDF - 0.007 \times CF + 1.05 \times GE$ (RSD = 0.326; $R^2 = 0.91$). Chemical composition alone gave the following equation: $DE = -2.68 - 0.021 \times CP - 0.10 \times Ash - 0.044 \times EE - 0.067 \times NDF - 0.023 \times CF + 1.14 \times GE$ (RSD of 0.341; $R^2 = 0.89$). With NIRS the most accurate statistical technique for predicting DE (MJ/kg) was MPLS which resulted in a standard error of calibration = 0.27 ($R^2 = 0.924$); standard error of cross validation = 0.408 (1-VR = 0.828) using the second derivative with scatter correction and 9 terms included. MPLS also gave the most accurate calibration and validation for digestibility of OM ($R^2 = 0.827$), energy ($R^2 = 0.772$) and N ($R^2 = 0.691$). In conclusion, NIRS and EFOS produced predictions of DE which were of similar accuracy.

Key Words: Pig, NIRS, Calibration

795 Evaluation of a diet formulation method that assigns nutrient values to microbial phytase in swine diets. J.S. Radcliffe^{*}, A.F. Harper, and E.T. Kornegay, *Virginia Polytechnic Institute and State University, Blacksburg.*

One hundred eighty crossbred grow-finish pigs with an average initial weight of 22.3kg were fed corn-soybean meal based diets. Dietary treatments were: 1) Positive control (100% NRC, 1998), 2) 90% NRC Lys, 100% Ca, P and other nutrients, 3) Formulated to be equivalent to diet 2 based on the inclusion of 500 U/kg of Natuphos600 phytase (BASF, Mount Olive, NJ) with assigned nutrient values 4) Formulated to the same ingredient levels as diet 3, but with no added phytase, and 5) Diet 4 with added Ca and P to meet NRC requirements. Dietary treatments were kept constant, but ingredient levels were altered based on NRC (1998) requirements for pigs during the grower (20-50kg), finisher I (50-80kg), and finisher II (80-110kg) phases. Pig BW and pen feed consumption were recorded biweekly. Fecal grab samples were collected from each pen during the last week of the finisher I phase. At the end of the experiment, all barrows were slaughtered for collection of third metacarpals. Feeding pigs at 90% of the NRC Lys requirement (diet 2) had no effect (P > .05) on ADG, ADFI, or gain:feed, compared to pigs fed diet 1. Pigs fed diet 3 had lower ADG (P < .05) than pigs fed diet 1, and ADG was further depressed in pigs fed diet 4 (P < .05). However, when Ca and P were added back to diet 4 (diet 5), ADG returned to a level similar to that of pigs fed diet 1 as a result of an increased (P < .05) feed efficiency. Pigs fed the 90% NRC Lys diet had a higher (P < .05) Ca digestibility compared to pigs fed the 100% NRC diet. Calcium digestibility was further improved by the addition of microbial phytase (P < .05). The digestibility of P, Ca, and DM were similar for pigs fed diets 1 and 2. The inclusion of phytase in diet 3 resulted in an increase (P < .05) in P digestibility relative to pigs fed diet 1, and an increase (P < .05) in DM and energy digestibility relative to pigs fed diets 1 or 2. Based on the results of this study, the formulation matrix designed for Natuphos appears to overestimate the P and Ca equivalency values of phytase.

Key Words: pigs, phytase, minerals

796 Dietary conjugated linoleic acid alters fatty acid composition of pig skeletal muscle and fat. T.G. Ramsay^{*1}, C.M. Evock-Clover¹, N.C. Steele¹, and M.J. Azain², ¹USDA-ARS, Beltsville, MD, ²University of Georgia, Athens.

This study examined the fatty acid profile of adipose tissue and skeletal muscle in pigs treated with dietary conjugated linoleic acid (CLA) and/or porcine somatotropin (pST). CLA was fed at doses of 0%, .25%, .5%, 1.0% or 2.0% to gilts and barrows from 20 to 55 kg BW. One additional group was treated with 50 mM bicarbonate buffer and 0% CLA, while two additional groups of animals were treated with pST (100 µg/kg BW) and either .5% CLA or 2.0% CLA. Animals were fed a diet containing 18% CP, 1.2% lysine, and 3.5 Mcal of DE/kg at 110% of ad libitum intake until slaughter at 55 kg BW. A half-carcass was ground in entirety and samples frozen for carcass analysis. The fatty acid profile in dorsal subcutaneous adipose tissue (SQ) and latissimus dorsi (LD) samples was determined by gas chromatography. CLA supplementation did not affect ADG, feed intake, feed efficiency or carcass composition. Dietary CLA produced significant changes in skeletal muscle and adipose tissue fatty acid composition. Dietary CLA at 1 or 2% produced an increase in the percentage of total fatty acids as stearic acid while the percentages as oleic and linolenic acids were reduced in LD. Linolenic acid appears to be the most sensitive to dietary CLA as a response in LD was observed with as little as .25% CLA. Treatment with CLA + pST increased the percentages of linoleic and arachidonic acids in LD fatty acids while reducing the percentages of palmitate and oleic acids. CLA increased the percentages of palmitic and stearic acids in SQ while reducing the percentages of oleic, linoleic, linolenic and arachidonic acids at dietary CLA concentrations as low as .25%. The percentage of total fatty acid as palmitic acid was reduced in SQ while linoleic acid was increased with CLA + pST administration. Thus, pST functions to enhance the percentage of polyunsaturated fatty acids while reducing the percentages of saturated fatty acids in skeletal muscle and adipose tissue of swine fed CLA.

Key Words: conjugated linoleic acid, fatty acids, carcass composition

797 Amino-Lac as a substitute for spray-dried animal plasma in starter diets for weanling pigs. G.L. Cromwell, M.D Lindemann, and H.J. Monegue*, *University of Kentucky, Lexington.*

Amino-Lac, a product consisting of concentrated whey, meat, and yeast proteins (International Ingredient Corp., St. Louis, MO), contains approximately 50% CP, 3.4% lysine, 3.0% fat, 35% lactose, .36% Ca, .52% P, and .57% Na. A 28-d experiment was conducted to assess Amino-Lac compared with spray-dried animal plasma (AP-920, American Protein Corp., Ames, IA) in Phase I starter diets for pigs. Crossbred pigs (n = 318) initially averaging 21.7 d of age and 6.5 kg BW were allotted to six treatments with ten pen-replicates of five or six pigs/pen. Phase I diets (1.4% lysine, 16% lactose) were fed for 14 d followed by Phase II diets (1.2% lysine, 10% lactose) for 14 d. Diets consisted of the basal (mainly corn, dehulled soybean meal, and lactose) and the basal with 2.5% plasma, 5% plasma, 5% Amino-Lac, 10% Amino-Lac, or a combination of 2.5% plasma and 5% Amino-Lac. During Phase II, pigs that previously received the Phase I basal diet were continued on the Phase II basal diet, whereas all other pigs received the Phase II basal diet with 2% spray-dried blood cells (AP-301G, American Protein Corp.). The Amino-Lac, plasma, and cells were substituted for corn and soybean meal on an equal lysine basis. All diets were fortified with vitamins, minerals, and an antimicrobial agent (carbadox, 55 mg/kg). Zn oxide (3,000 ppm Zn) and Cu sulfate (250 ppm Cu) were included in the Phase I and II diets, respectively. Diets were fed in meal form. During Phase I, gain and feed/gain were improved ($P < .05$) when plasma or Amino-Lac was included in the diet (307, 338, 344, 323, 341, 354 g/d; 1.34, 1.25, 1.18, 1.21, 1.15, 1.16, respectively) but feed intake was not affected (406, 421, 404, 380, 387, 405 g/d). Similar improvements ($P < .05$) in gain and feed/gain occurred over the entire 28-d test period (458, 486, 488, 476, 489, 492 g/d; 1.53, 1.46, 1.42, 1.47, 1.46, 1.45), but feed intake was unaffected (698, 713, 694, 698, 716, 711 g/d). The results indicate that Amino-Lac is comparable to spray-dried animal plasma on a lysine basis in starter diets for early-weaned pigs.

Key Words: Pigs, Plasma, Lactose

798 Use of animal protein sources in combination with different types of milk protein in diets for early-weaned piglets. P. Medel¹, F. Baucells², M.J. Aranibar¹, and G. G. Mateos¹, ¹Dpto. Producción Animal, Universidad Politécnica de Madrid, ²Pinosos Baucells, Barcelona, Spain.

A trial was conducted to evaluate the influence of milk and two animal protein sources in diets for piglets. There were four diets (2,500 kcal NE/kg and 1.35% digestible lysine) arranged as a factorial 2x2 with two types of milk protein: casein and whey protein, and two high quality animal proteins: fish meal LT and poultry meat meal. Lactose permeate was added to the casein based diets to maintain constant the lactose content of the diets. Each treatment was replicated 6 times (5 male piglets caged together). The four experimental diets were fed from weaning at 21 d until 41 d of age. Then, all the animals received a common starter diet (2,435 kcal NE/kg and 1.07% digestible lysine) until 51 d of age. No differences were detected among milk or animal protein sources for growth or feed intake from 0 to 20 d. However, a significant interaction was observed for feed conversion at this period: it was improved in poultry meat meal diets that included whey (1.16 vs 1.06 g/g), but was impaired in the diets that included casein (1.07 vs 1.12 g/g). Piglets fed fish meal LT from 21 to 41 d of age grew faster from 41 to 51 d than animals fed poultry meat meal LT although in this period the animals received a common diet (543 vs 472 g/d, $P=0.05$). No differences in any productive performance traits among treatments were observed at the end of the trial. It is concluded that milk protein source did not influence piglet performance at 51 d, and that high quality poultry meat meal allowed similar performance of piglets than fish meal LT.

Key Words: Milk proteins, Fish meal, Poultry meat meal

799 Efficacy and pH dependence of phytate-phosphorus hydrolysis by four different phytases are modulated by buffer and substrate specificities. T. Xiang*, E. Rodriguez, J.R. Thornton, and X.G. Lei, *Cornell University, Ithaca, NY.*

We have expressed *Escherichia coli*, *Aspergillus flavus*, and *A. fumigatus* phytase genes in yeast and obtained partially-purified enzymes.

This study was to determine effects of buffer, pH, and substrate on the efficacy of phytate-P hydrolysis by these three phytases, in comparison with those of Natuphos. In Exp. 1, hydrolyses of sodium phytate by these four enzymes were compared at pH 2.5 to 5.5 in eight different combinations of 0.2 M citrate, acetate, and glycine-HCl as the reaction and/or the substrate buffers. There was a strong interaction ($P < 0.01$) between the buffer system and pH on the efficacy of all four enzymes. Although the highest efficacy of the three *Aspergillus* phytases occurred at pH 5.5 within a given buffer system, the previously-reported pH 2.5 optimum for Natuphos was not seen in several buffers. The best buffer combination for the catalysis of these fungal enzymes was acetate and citrate as the reaction and substrate buffer, respectively. The *E.coli* phytase exhibited its pH optimum at 3.5 and had greater ($P < 0.01$) P release in the acetate reaction buffer than in others. In Exp. 2, these four phytases (0.6 units) were incubated for 1 h with 2 g soybean meal (SBM) suspended in 0.2 M citrate or acetate buffer, pH 3.5 or 5.5. While the citrate buffer allowed the three fungal phytases to release more P from SBM than the acetate buffer at pH 5.5 ($P < 0.05$), these two buffers were not different for the hydrolysis of this intrinsic phytate by the *E.coli* phytase at pH 3.5 or 5.5. In Exp. 3, hydrolyses of sodium phytate and calcium phytate by the *E.coli* phytase were compared in 0.2 M acetate and citrate, pH 3.5. There was a difference ($P < 0.05$) in P released from only sodium phytate, but not calcium phytate between these two buffers. In conclusion, efficacy of phytases on phytate-P hydrolysis is highly affected by the nature of buffer and substrate, and their pH optima are not inherent.

Key Words: Phytase, Phytate, Buffer

800 Effects of betaine levels in reduced energy diets for finishing pigs. G.L. Cromwell*, M.D Lindemann, J.R. Randolph, K.M. Laurent, G.R. Parker, and R.D. Coffey, *University of Kentucky, Lexington.*

Previous research at our station suggested that betaine was more effective in low energy diets than in typical corn-soy diets. Two experiments were conducted to assess dietary levels of betaine as a carcass modifier in reduced energy diets. Two dietary energy levels (3,325 vs 3,175 kcal ME/kg) were achieved with a fortified corn-soybean meal diet (Diet 1) or a similar diet with 20% wheat middlings (Diets 2-5). Middlings were substituted for corn and soybean meal on a lysine basis. Betaine was included in Diets 2-5 at 0, .68, 1.14, and 1.82 g/kg of diet by adding 0, .075, .125, or .200% Betafin (Finnfeeds, Fenton, MO). Crossbred pigs (8 reps of 4-5 pigs/pen, n = 165) were fed the 5 diets from 56 to 111 kg BW. Dietary lysine was reduced from .85 to .70% at 84 kg BW. All pigs were scanned by real-time ultrasound at 106 kg BW for backfat (BF) and longissimus depth (LD), and carcass lean was estimated from these measurements. Carcass BF, longissimus area (LEA), and estimated lean were determined on all barrows at termination. Means for the 5 treatments were, respectively: gain (ADG), 934, 901, 913, 895, 905 g/d; feed/gain (F/G), 3.41, 3.69, 3.59, 3.61, 3.75; scanned BF, 19.3, 18.9, 17.9, 18.5, 19.2 mm; scanned LD, 5.46, 5.29, 5.31, 5.48, 5.37 cm; estimated lean, 53.3, 53.3, 54.0, 53.8, 53.3%; and lean gain, 375, 361, 377, 367, 363 g/d. Carcass 10th rib BF, LEA, and estimated lean of barrows were, respectively: 26.4, 26.0, 22.5, 23.3, 26.0 mm; 35.3, 35.3, 36.5, 36.8, 34.9 cm²; 48.6, 48.9, 50.8, 50.6, 48.9%. ADG was reduced ($P < .10$) and F/G was increased ($P < .01$) in pigs fed the low energy diets. Betaine level did not influence ADG, but affected F/G quadratically ($P < .03$). Feeding the low energy diets tended to reduce scanned and carcass BF, but not significantly ($P = .30$). Barrow carcass responses to betaine tended to be quadratic ($P < .07$ for BF and estimated lean). The .68 and 1.14 g/kg levels of betaine seemed to be effective in reducing backfat and increasing lean percentage and lean gain; whereas the 1.82 g/kg level was ineffective.

Key Words: Pigs, Betaine, Energy

801 Effects of nursery diet and supplementation with a combination of dietary acidifiers, enzymes and flavor on pig performance. B. F. Wolter¹, M. Ellis¹, A. V. Frampton¹, R. A. Easter¹, E. Roura², J. Brenes², and J. Sola², ¹University of Illinois, Urbana, ²Lucta SA, Barcelona, Spain.

This study tested the effects of three dietary supplements (added at .5%) (control [1, sodium bentonite] and two commercial supplements [2, 3, (Luctaplus[®], Lucta SA)] containing a combination of inorganic and organic acids, a blend of enzymes, and a flavor) in two diet formulations

(A and B) on pig performance for 2 wk post-weaning. Crossbred pigs (n=288; 5.2±.66 kg BW; 18±2 d of age) were allotted (12 reps) to six treatments; 1) 1A; 2) 2A; 3) 3A; 4) 1B; 5) 2B; 6) 3B. Groups of 4 pigs were given ad lib access to a two-phase regimen (Table) with each phase fed for 1 wk. Diets differed in soy- and animal-based protein content, but had an equal lysine to energy ratio within each phase. The control treatment with lower SBM content (1A), compared to the control with higher SBM content (1B), resulted in heavier pig weights (5 and 9%, P<.06), greater ADG (43 and 20%, P<.08), greater G/F (31 and 8%, P<.10), but similar ADFI (P>.10) in wk 1 and 2, respectively. The supplements had no effect (P>.10) on the performance of pigs consuming the low SBM diet (A) during either phase (e.g. ADG 138 vs 142 vs 153, and 346 vs 322 vs 336 g/d for A1, A2 and A3 and for phase 1 and 2, respectively). In the high SBM diet (B), the supplements (2B and 3B) produced similar (P>.10) ADG (129 and 127 vs 138, SE=16.1 g/d, and 323 and 331 vs 346, SE=16.7 g/d for phase 1 and 2, respectively) ADFI (144 and 138 vs 147, SE=13.6 g/d and 389 and 397 vs 419, SE=18.4 g/d for phase 1 and 2, respectively) and G/F (.90 and .91 vs .93, SE=.062 and .83 and .84 vs .83, SE=.024 for phase 1 and 2, respectively) compared to the control, low SBM diet (1A). These results suggest that using the particular combinations of acid blend, enzyme blend, and flavor used in this study prevents a reduction in pig performance when replacing more digestible animal-protein feedstuffs with SBM in a nursery diet.

Phase/ Diet	Corn	Whey	SBM	Plas- ma	R oat	Fish M	Oil	AA's	Vit/ Min	Lys	ME
1/A	31.3	23.0	8.0	6.5	13.5	12.5	2.5	.1	2.1	1.65	3356
1/B	32.7	23.0	20.0	2.4	6.5	7.2	4.1	.5	3.1	1.65	3356
2/A	46.4	18.0	18.0	3.0	-	8.5	2.7	.1	2.8	1.44	3344
2/B	44.0	18.0	25.0	1.0	-	3.0	4.1	.5	3.9	1.44	3344

Key Words: Pigs, Diet Complexity, Dietary Supplement

802 Phytase in low phosphorus corn-soybean meal diets for finishing swine: Calcium and phosphorus absorption and excretion. T. L. Veum*¹, D.W. Bollinger¹, and D.R. Ledoux¹, ¹University of Missouri, Columbia.

This experiment was conducted to evaluate lower, more cost effective phytase concentrations on P absorption and excretion by finishing pigs (n = 120, 51.5 kg initial and 123 kg final BW) fed a low-P corn-soybean meal diet. Growth performance and bone breaking strength have been reported (J. Anim. Sci. 75, Suppl. 1:68). The basal low-P diet with no added inorganic P contained .32% total (t)P, .05% available (a)P and .38% Ca. The basal low-P diet was supplemented with 0, 150, 300 or 450 phytase units (PU)/kg (Natuphos 5,000, BASF, Inc.). The positive control (PC) diet contained .41% tP, .15% aP, and .50% Ca. The Ca:tP ratio as kept at 1.2:1 in all diets by reducing Ca below the NRC requirement in the low-P diets. All diets contained 13% CP, .66% lysine and 3.45 Mcal of ME/kg. Chromium oxide was added to the diets at .05% for a two week period midway through the experiment as a nondigestible indicator. Fecal samples were collected from each pen (experimental unit) daily for four consecutive days. There were linear increases (P<.01) in Ca and P absorption and linear decreases (P<.01) in fecal P excretion with increasing concentration of phytase. Absorption of P (g/d) was similar (P≥.2) for the PC and the 450 PU/kg treatments. Fecal P excretion (g/d) was reduced (P<.01) 37 and 38% by the 300 and 450 PU/kg treatments, respectively, compared to the PC. In conclusion, phytase was effective in increasing P absorption and reducing P excretion in low-P corn-soybean meal finishing diets.

Key Words: Swine, Finishing, Phytase

803 Soybean protein products affect nutrient digestibilities and fecal characteristics of dogs. G. M. Clapper*¹, C. M. Grieshop¹, N. R. Merchen¹, J. C. Russett², and G. C. Fahey, Jr.¹, ¹University of Illinois, Urbana, ²Central Soya Company, Inc., Fort Wayne, IN.

Plant-based protein sources are generally less variable in chemical composition as compared to animal-based protein sources. However, relatively little data are available on the nutrient digestibility of plant-based protein sources by companion animals. The effects of including selected soybean products in dog diets on nutrient digestion at the ileum and in the total tract, as well as fecal characteristics, were evaluated. Six protein sources were utilized: soybean meal (SBM), Soyafluff 200W (soy

flour), Profine F [traditional aqueous-alcohol extracted soy protein concentrate (SPC)], Profine E (extruded SPC), Soyarich I (modified molecular weight SPC), and poultry meal (PM). Diets were extruded and kibbled. Protein sources varied widely in crude protein (CP) and fat content; however diets were isonitrogenous and isocaloric. Nutrient intakes were similar, except for total dietary fiber (TDF), which was lower for dogs fed the PM diet. No differences (P>.05) were observed in dry matter (DM) intake. Ileal digestibilities of DM, organic matter (OM), fat, and TDF were not different (P>.05); however, CP digestibility at the terminal ileum tended (P<.06) to be higher for diets containing plant-based protein sources compared to the PM diet. Total tract CP digestibility was greater (P<.02) when feeding plant-based proteins vs. PM diets. Dry matter, OM, fat, and TDF total tract digestibilities were not different (P>.05) among treatments. As-is fecal weight was highest (P<.05) for dogs consuming the soy flour diet; however excretion of feces by dogs consuming the SPC diets was not different from that of dogs consuming the PM diet. Fecal weight on a DM basis was higher (P<.05) for the soy flour treatment as compared to all other treatments, and the SPC treatments were not different (P<.05) from the PM treatment. Soy protein concentrates offer a viable alternative to PM as a protein source in premium canine diets.

Key Words: Dog, Soy, Nutrient digestibility

804 Effect of liquid whey and L-glutamine supplementation on the productive parameters and intestinal integrity of the piglet and early-weaned pig. B. Sanchez¹, A. De La Cruz¹, G. Villar¹, R. Mendoza¹, G. Mariscal², and G. Borbolla*¹, ¹Facultad de Medicina Veterinaria y Zootecnia U.N.A.M., ²Centro Nacional de Investigación Disciplinaria.

The effect of L-glutamine on the small intestinal mucosa (SIM) of the piglet and early-weaned pig and its performance were evaluated in this study. One hundred and one lactating pigs (7d of age) were randomly distributed into three treatment groups. In the first group (C), besides the milk provided by the sow, the piglets had unrestricted access to a drinker containing tap water. Pigs in the second group received fresh cow liquid whey (LW), while animals in the third group (LWG) had unlimited access to liquid whey and 1% L-glutamine (glutamine). All the solutions were changed in a daily basis and drinkers replenished as needed. At weaning (d 21), eight pigs per treatment were killed and samples of the SIM were taken for histological evaluation. The remaining pigs were transferred to another facility and fed a corn-soybean base diet (1.2% lys, and 3240 ME Mcal/kg). For seven days more, the pigs received the same solution as during the lactation period. Animal exposed to liquid whey with or without glutamine had a superior (P<.01) daily liquid consumption when compared to pigs with access to tap water (1486, 1201 and 625 ml, respectively), The same trend (P<.01) was observed with feed consumption (117, 106 and 65 g/day, respectively). For ADG, diarrhea and mortality, there were not differences (P>.05), among treatment groups. However the ADG was numerically superior in the treatments LW and LWG when compared with the C (157, 137 and 119 g/day, respectively). The inclusion of glutamine improved (P<.06) the jejunum villus height when compared to the LW and C groups (356.3, 332.2 and 272.3 μm, respectively). The use of L- Glutamine and liquid whey in the piglet and early weaned pigs can decrease the damage to the small intestine mucosa observed at weaning, and improved feed consumption.

Key Words: Piglet, Early Weaning, Glutamine

805 Order of limiting amino acids in a practical corn-soy diet for growing pigs. M.E. Johnston*¹, R.D. Boyd¹, C.E. Fralick², and J.L. Usry³, ¹PIC USA Inc., Franklin, KY, ²Swine-Tek Research and Consulting, Van Wert, OH, ³Heartland Lysine Inc., Chicago, IL.

The objective was to determine if threonine or tryptophan is more limiting for grower pigs (37.3 to 62.7 kg BW) fed corn-soy diets. PIC337 x C22 castrates and gilts (48 pens, 10 pigs/pen) were sorted by weight and randomly allotted to one of eight diets (37.3±0.6 kg, 60 pigs/treatment). The control diet (1) contained corn and soy as the only amino acid sources (0.88% true ileal digestible lysine (TIDLys)). A negative control diet (2) limiting in TIDLys (0.80%) was also formulated using corn and soy as the only amino acid source. In diets 3, 4, and 5 L-lysine was added at 0.15, 0.225, and 0.30%, respectively, to maintain a 0.80% TIDLys level. Diet 6 contained 0.30% L-lysine and 0.10% L-threonine

(TIDThr:Lys ratio=65%). Diet 7 was the same as diet 6 plus 0.05% DL-methionine (TIDM+C:Lys ratio=62%). Diet 8 was formulated as diet 7 with the addition of 0.03% L-tryptophan (TIDTrp:Lys ratio=19%). Feed intake was unaffected ($P > .35$) by dietary treatment. There was a numerical increase in feed conversion (GF) when pigs were fed diet 2 vs 1 suggesting that TIDLys was limiting in diet 2. Pigs fed diets 4 and 5 had decreased ($P < .01$) ADG compared to pigs fed diet 2 (0.88 and 0.87 vs 0.92 kg/d). The addition of threonine to diet 6 resulted in a numerical improvement in ADG (0.90 kg/d) compared to pigs fed diets 4 and 5 and GF (0.44) equal to diet 2. With the addition of DL-methionine and tryptophan to diet 8, pigs had ADG (0.94 kg/d) comparable to pigs fed the control diet (0.93 kg/d) even though the TIDLys level was lower. The data indicate that threonine is second limiting in practical corn-soy diets and that the addition of 0.10% L-threonine will give comparable results as a corn-soy diet with no added synthetic amino acids but formulated to the same TIDLys level. Addition of threonine, methionine, and tryptophan to a diet containing 0.30% L-lysine tended to improve ADG and GF so that no difference existed between the control and amino acid supplemented diets.

Key Words: Pigs, Lysine, Threonine

806 Pork quality characteristics of pigs fed different types of fat and high levels of vitamin E. E. van Heugten* and M. T. See, *North Carolina State University, Raleigh.*

An experiment was conducted to evaluate the effects of short term vitamin E supplementation on pork quality of pigs ($n=300$, 88.5 kg initial BW) fed saturated or unsaturated types of fat. Pigs were allotted to 60 pens based on body weight, sex, and litter of origin and received one of 10 dietary treatments during the final 6 wk of the finisher period. Treatments were arranged in a 2 x 5 factorial randomized complete block design. Factors included: 1) fat type (choice white grease or soybean oil) and 2) supplemental vitamin E level (0, 100, 200, 400, or 800 mg/kg). The basal corn soybean meal diet contained 5% fat, 15 mg/kg vitamin E and 0.75% lysine. Pigs were slaughtered at a commercial plant and loin samples obtained 24 h post-mortem. Performance and carcass characteristics were not affected ($P > .27$) by fat type or vitamin E. Muscle vitamin E concentration increased linearly ($P < 0.01$) from 3.22 mg/kg to 6.65 mg/kg for pigs fed 0 to 800 mg/kg of vitamin E in diets containing soybean oil. In pigs fed choice white grease, muscle vitamin E concentration increased quadratically ($P < 0.06$) and reached a maximum (5.92 mg/kg) at 400 mg/kg of vitamin E. Minolta L* and b* values were lower (less pale and yellow, respectively) for loin chops from pigs fed either 0 or 400 mg/kg of vitamin E compared with pigs fed 200 mg/kg of vitamin E ($P < 0.05$). Pork redness (a* value) and drip loss were not affected by treatments ($P > 0.16$). Oxidative stability (TBARS) of cooked loin samples was decreased in pigs fed soybean oil ($P < 0.02$) compared to pigs fed choice white grease. Oxidative stability (measured only for diets containing 0, 400, or 800 mg/kg of vitamin E) was improved by 400 mg/kg of vitamin E, but no further improvement was observed with 800 mg/kg ($P < 0.10$). These results suggest that the extent of vitamin E accumulation in loin muscle depends on dietary fat type. Furthermore, vitamin E supplementation and fat type had minimal effects on fresh pork quality, but have the potential of improving oxidative stability of cooked product.

Key Words: Vitamin E, Fat, Pork Quality

807 Effect of iron supplementation of piglets on bioavailability of iron in ferrous sulfate. B. K. Anderson*, N. R. Augspurger, and M. Ellis, *University of Illinois, Urbana.*

This study tested the effect of iron supplementation of piglets on bioavailability of iron (Fe) in ferrous sulfate using hemoglobin (Hb) depletion/repletion. A slope-ratio design used sixty pigs ($4.69 \pm .34$ kg BW, and $18.44 \pm .34$ d of age) from six litters of a commercial genotype (PIC L-337 x PIC C-22) were utilized in a 2x5 factorial arrangement of treatments in which two levels of iron supplementation (0 or 30 mg) were given via IM injection at birth, and five dietary levels of iron (27, 52, 77, 102, or 127 ppm) were fed during a 21-d study period. Post-weaning, pigs were moved to plastic nursery pens and randomly assigned to dietary treatment from outcome groups formed on the basis of supplementation level, litter and weight. A basal diet based on dried skim milk and corn contained 27 ppm Fe. Experimental diets were formulated from aliquots of the basal diet to have incremental additions of 25, 50, 75, and 100 ppm Fe via substitution of corn starch

with ferrous sulfate. Pigs were given ad libitum access to assigned diets for 3 wk and feed disappearance and weight gain were recorded for the period. Initial and final blood samples were obtained by jugular puncture and Hb concentrations were measured colorimetrically. Initial Hb concentration was different ($P < .008$) between supplementation levels; however, no difference between dietary levels was detected. Supplementation level exhibited no effect on ADG and ADFI, but both parameters increased significantly ($P < .001$ and $P < .03$, respectively) in response to increasing dietary iron concentration. Final plasma Hb concentration was affected significantly ($P < .02$ and $P < .001$) by increasing both supplementation level and dietary iron concentration. The regression of final hemoglobin and average daily iron intake was determined to be linear (0 mg: $Y=3.933948$ (SE .68012390) + .069948 (SE.01376826) * Iron intake; $R^2=.5398$; $P < .001$. 30 mg: $Y=5.998730$ (SE .41543038) + .050084 (SE .00818588) * Iron intake; $R^2=.5901$; $P < .001$). This study suggests iron supplementation at birth does affect the estimate of iron bioavailability in ferrous sulfate.

Key Words: Pigs, Iron, Bioavailability

808 Growth rate, carcass composition and onset of estrus in developing gilts fed cottonseed meal. T.C. Schell*¹, C.R. Dove¹, and D.K. Bishop², ¹University of Georgia, ²Brown's of Carolina.

Ninety-three crossbred gilts (ave initial wt, 54.7 kg) were used to evaluate the effects of feeding one of three levels of cottonseed meal (0, 7.5, or 15%) to developing gilts. At the initiation of the trial, the diets were formulated to contain 16.5% CP, 0.85% lysine, and 1550 kcal ME. When the gilts reached an average body weight of 91 kg the diets were formulated to contain 15.5% CP, 0.75% lysine and 1550 kcal ME. The control diet was a corn-soybean meal based diet. For the treatment diets, cottonseed meal (CSM) replaced soybean meal. Fat and synthetic lysine were used as necessary to balance for energy and lysine. The CSM contained 1.2% total gossypol and 0.09% free gossypol. Gilts were penned four to a pen and when the average body weight of a pen reached 91 kg, the pen was given fence exposure to boars for at least 15 min twice a day. After the average body weight of a pen reached 109 kg, gilts were individually heat checked twice a day using a boar. After reaching a standing estrus, gilts were removed from the pen and trial. Age, weight, 10th rib backfat depth, loin eye area, ADG, and feed intake were compared when the gilts reached their first estrus. Feeding CSM reduced the days to first estrus linearly ($P < .05$). Gilts fed the 0, 7.5 and 15% CSM reached first estrus at 186 d, 181 d and 177 d respectively. Feed intake increased as the level of CSM in the diet increased (3.3, 3.1 and 3.5 kg/d, linear effect, $P < .01$). Feeding CSM meal also tended ($P < .08$) to increase ADG to first estrus (1.92, 1.92 and 2.02 kg/d respectively). However, the gilts fed the 7% CSM had the best ($P < .05$) feed efficiency (G/F: 0.29) compared with the gilts fed other two diets (0.27). There were no differences in body weights (125 kg), 10th rib backfat depth (29 mm) or loin eye area at estrus. In summary, feeding up to 15% CSM to developing gilts can reduce the number of days to first estrus, increase ADFI and ADG to first estrus and produce carcass characteristics similar to those of gilts fed soybean meal.

Key Words: Swine, Cottonseed meal, Puberty

809 Iron bioavailability in Methiron 65 measured by hemoglobin regeneration in anemic rats. I. Mejia-Haro*¹ and H.-Y. Chen², ¹CIGA ITA de Ags., Mexico, UNL, ²University of Nebraska, Lincoln.

The objective of this study was to determine the bioavailability of iron (Fe) in Metiron 65. Thirty male weaned rats were fed individually an iron deficient diet (7 ppm) for 1 wk (depletion period). Twelve rats were completely randomized and assigned to one of three treatments (a purified diet with different levels of supplemented Fe); T1, 8 mg/kg; T2, 16 mg/kg; and T3, 24 mg/kg for a 3-wk period. The control group (CG) consisted of 18 rats fed the purified diet with no Fe supplement. Ferrous sulfate heptahydrated was used as a standard to which data were compared. Rats were weighed at the beginning of the depletion period and every week. Another group of 10 rats was sacrificed prior to the depletion period to know the degree of Fe depletion. At the end of the experiment, blood samples were taken and hemoglobin concentration (HbC) was determined. Data of average daily gain (ADG), daily feed intake (DFI), HbC, Hb repletion (HbR), HbFe retention and HbFe efficiency were calculated. Values of HbR, HbC and efficiency of HbFe

were compared with the standard source by slope ratios. Data were analyzed by ANOVA and slope ratio methods. The lowest HbC ($P < .01$) was found in rats of CG, followed by rats of T1 and T2 and the highest value in rats of T3. The value of DFI was lower ($P < .01$) in CG than in T2 and T3 and higher in T2 than T1 and T3. ADG in CG was lower ($P < .05$) than the rest of the treatments; T2 was higher ($P < .01$) than T1 and T3. Rats in T2 had the greatest ADG and compared to the standard source, Methiron presented a relative efficiency of 123%. HbR was lower ($P < .01$) in CG and higher in T2 and T3; HbFe efficiency was only different between CG and T1, ($P < .01$) and ranged from 57 to 69%. HbR was higher ($P < .01$) in T2 and T3 than in T1 and CG. Comparing these data with those of the standard, an efficiency of 67% was calculated for Methiron 65. Values of HbC and HbR were inversely related to ADG and the relative availability of Fe in Methiron 65 was lower than that of the standard when the response was HbC and HbR and higher for ADG. Response to dietary Fe intake is different in ADG and Hb regeneration.

Key Words: Iron, Bioavailability, Rats

810 Effects of vitamins and minerals on growth performance and pork quality in finishing pigs. J. S. Park*, J. D. Hancock, D. H. Kropf, R. H. Hines, C. L. Jones, D. J. Lee, D. W. Dean, and N. Amornthawaphat, *Kansas State University, Manhattan.*

A total of 80 crossbred pigs (average initial BW of 84 kg) were used to determine the effects of manipulating vitamin and mineral concentrations in late finishing on growth performance and pork quality. There were two pigs per pen and 10 pens per treatment. The basal diet was corn-soybean meal-based with treatments arranged in a split-plot design. Whole plot treatments (phase 1) were: 1) no vitamin/trace mineral premixes; and 2) standard additions of vitamin and mineral premixes from 84 kg to 102 kg BW. For 102 kg to slaughter at 120 kg (phase 2), subplot treatments (no change in vitamin/trace mineral supplementation vs addition of a special premix with 500 mg/kg of vitamin E, 500 mg/kg of vitamin C, 200 mg/kg of Mg from magnesium proteinate, and 150 mg/kg of Fe from iron proteinate) were imposed within the whole-plot treatments. For 84 kg to 102 kg, removing vitamin and trace mineral premixes did not affect ADG ($P > .15$), ADFI ($P > .80$), or gain/feed ($P > .28$). For 102 kg to slaughter, growth performance also was not different ($P > .11$) among pigs fed diets without or with vitamin/trace mineral premixes. Furthermore, measurements of meat quality (pH, color, marbling, firmness, drip loss, thawing loss, cooking loss, shear force, and hunter $L^*a^*b^*$) were not affected ($P > .15$) by removing vitamin/trace mineral premixes or addition of the special premix. In conclusion, removing vitamin/trace mineral premixes and/or supplementation with extra vitamin E, vitamin C, Mg, and Fe did not affect growth performance or meat quality in finishing pigs.

Key Words: Vitamin, Mineral, Finishing pig

811 Separation and detection of essential amino acids using High Performance Liquid Chromatography (HPLC). J. Aranda-Ruiz*, R. González-González, E. Gutiérrez-Ornelas, H. Bernal-Barragán, and E. Olivares-Sáenz, *Universidad Autónoma de Nuevo León, México.*

The objective of this study was to develop a technique for analysis of amino acids using high performance liquid chromatography (HPLC) in feed ingredients. A solution (30 μ l of 100 mM) of each one of the 10 essential amino acids, as well as mixtures of the 10 amino acids (30 μ l of each one) were placed in Eppendorf tubes. Dilutions of the amino acids standard (1.25, 2.5, 5, 7.5, 15 and 30 η M) were made in order to carry out a calibration curve. All these solutions were subjected to derivatization using 200 μ l of methanol, 50 μ l of triethylamine and 30 μ l of phenylisothiocyanate. The derivatized amino acids were lyophilized and resuspended in 2 ml of methanol. The chromatography was carried out injecting 10 μ l of the sample in the HPLC equipment. It was used a column of reverse phase ODS (C18 of 244 mm, 4mm of internal diameter with a size of particle of 4 microns). It was used a UV-V detector with a wavelength of 254 nm. The attenuation was of 100 millivolts. The elution was in a gradient, using sodium acetate 0.03 M pH 6.4 as a buffer (Solution A) and a mixture of acetonitrile and water 60:40 (Solution B). Linearity, repeatability, reproducibility and limit of detection were evaluated. The coefficient of variation (CV) of the repeatability of the analysis was less than 1% for most of the amino acids. The CV for reproducibility was less than 7% for most of the amino acids. The

regression coefficient for linearity was 0.98. The limit of detection was as low as 0.125 nM.

Key Words: Amino acid analysis, HPLC, Feed analysis

812 Methodology of measuring phosphorous digestibility in feedstuffs for pigs. M. Z. Fan*¹, T. Archbold¹, D. Lackeyram¹, T. Rideout¹, Y. Gao¹, R. R. Hacker¹, C. F. M. de Lange¹, W. C. Sauer², and E. J. Squires¹, ¹*University of Guelph*, ²*University of Alberta, Canada.*

The objective of this study was to develop a valid method for measuring phosphorous digestibility in feedstuffs for pigs. Soybean meal was used as a "model feedstuff". Four Yorkshire barrows, with an average initial weight of 10 kg, were fitted with a simple T-cannula at the distal ileum and fed four diets according to a 4 x 4 Latin square design with four experimental periods. The diets were cornstarch-based containing four levels of phosphorous from soybean meal (.09, .18, .27 and .35, respectively, on as-fed basis). Chromic oxide (.4%) was included as a digestibility marker. Each experimental period consisted of 8 d with 4-d adaptation and 4-d collection of representative ileal digesta and fecal samples. Apparent ileal and fecal phosphorous digestibility values in soybean meal were determined by the marker technique, whereas true ileal and fecal phosphorous digestibility values were determined by the regression analysis technique. The apparent ileal and fecal phosphorous digestibility values were affected ($P < .05$) by phosphorous levels in the assay diets. Apparent ileal and fecal phosphorous digestibility in soybean meal increased from -24.8 to 37.1% and from 18.8 to 45.2%, respectively as dietary phosphorous content was increased from .09 to .35%. There was no difference ($P > .05$) between the true ileal (50.7 ± 7.1) and the true fecal (48.5 ± 5.4) phosphorous digestibility (%) in soybean meal, indicating that the large intestine does not contribute to phosphorous absorption. Our results suggest that differences in phosphorous content between assay diets are primarily responsible for the reported large variability in apparent phosphorous digestibility values within the same feedstuff. True rather than apparent phosphorous digestibility should be determined in feedstuffs and used in diet formulation for swine.

Key Words: Phosphorous, Digestibility in Pigs, Soybean meal

813 A dynamic model to estimate nutrient requirements in pregnant and lactating sows. J. G. Kim*, Y. W. Shin, and K. Y. Whang, *Korea University, Seoul, Korea.*

A dynamic computer model was developed to estimate the energy and protein requirements in pregnant and lactating sows and propose the customized feeding program based on body weight (BW) and body condition. Input variables were BW and P2 backfat depth (P2) at breeding, expected fetus number and litter size. The BW and P2 were used to determine the body components. During gestation, sow growth was divided into two segments, maternal and conceptus growth. The potential maternal BW gain during gestation was derived from the BW at breeding. Body weight changes of pregnant sows calculated from published data were used to determine the maternal growth pattern, and equations were adapted to estimate the energy and protein requirements for conceptus growth. The P2 at farrowing was calculated according to potential BW gain and ideal maternal body condition. The energy and protein requirements of conceptus were determined by fetus number. Fetus number in pregnancy and litter size in lactation were not necessarily the same, and the litter size was a factor that influenced on the energy requirement of lactating sows. The energy requirement for milk production was decided by the expected milk consumption by piglets or milk production capacity of sows, whichever was smaller. Regression equations of the estimated energy (E, KJ/d) and protein requirements (P, g/d), employing BW and day (D) as factors, are as follows: during gestation, $E_G = 188500 \cdot \exp(-0.5 \cdot ((BW-214)/161.9)^2 + ((D-1210)/638.4)^2)$ ($r^2 = 0.94$) and $P_G = 1710 \cdot \exp(-0.5 \cdot ((BW-159)/94.7)^2 + ((D-1120)/539)^2)$ ($r^2 = 0.84$), and during lactation, $E_L = 118403 \cdot \exp(-0.5 \cdot ((BW-693.1)/689.5)^2 + ((D-16.7)/14.8)^2)$ ($r^2 = 0.99$) and $P_L = 1074.2 \cdot \exp(-0.5 \cdot ((BW-989.1)/1901.1)^2 + ((D-17.4)/14.3)^2)$ ($r^2 = 0.99$). Estimated values by the model indicate that the energy and protein requirements vary markedly with potential body growth and the litter size. In late gestation, the rates of increase in energy and protein requirements of heavier sows are relatively higher than those of lighter sows. These results also suggest that NRC sow model (1998) generally overestimated the protein requirement

but underestimated the energy requirement during both gestation and lactation periods.

Key Words: Sows, Dynamic Model, Nutrient Requirements

814 Effects of dietary supplementation of diatomaceous earth and zeolite on ammonia and hydrogen sulfide emission from growing-finishing pigs fed corn and soybean meal-based diets. Y. Gao^{*1}, T. Rideout¹, D. Lackeyram¹, T. Archbold¹, M. Z. Fan¹, E. J. Squires¹, C. F. M. de Lange¹, T. K. Smith¹, and G. Duns¹, ¹*University of Guelph*.

A trial was conducted to examine the effects of dietary supplementation of two natural binding compounds, i.e., diatomaceous earth and zeolite, on ammonia and hydrogen sulfide emission from swine slurry. Six Yorkshire barrows, initial wt of 25 kg, were fed six diets according to a 6 x 6 Latin square design with six experimental periods. The diets were corn and soybean meal-based, contained the same amount of protein and amino acids and differed in the source and level of binding compounds. Diet 1 had no binding compounds and served as the control; diets 2, 3 and 4 were with 1.2, 2.4 and 3.6% of diatomaceous earth, respectively; diets 5 and 6 were with 0.6 and 1.2% of zeolite, respectively. Each period lasted for 14 d with 10-d adaptation followed by 4-d collection of feces and urine. For each period, fresh manure slurry was made by mixing the collected fresh feces with urine at a ratio of 1:2.5 (wt/wt). Accumulative ammonia and hydrogen sulfide emission from the slurry of different dietary treatment conditions was measured with our recently established trapping system at different time points (0, 24, 30, 54, 78 and 102 h, respectively) at the room temperature. Supplementing diatomaceous earth in the diets 2, 3 and 4 respectively decreased the 102-h accumulative NH₃ emission by 27.4, 41.5 and 43.9% (11.9, 9.6 and 9.2 vs. 16.4 g NH₃/kg DM slurry) in comparison with the control diet. Furthermore, adding zeolite at the level of 0.6 but not at the level of 1.2% also decreased the 102-h accumulative NH₃ emission by 29.3% (11.6 vs. 16.4 g NH₃/kg DM slurry) in comparison with the control diet. However, adding both diatomaceous earth and zeolite appeared to have no effects (P>.50) on H₂S emission from the slurry. In conclusion, adding diatomaceous earth in swine diets can effectively decrease ammonia emission from swine manure slurry.

Key Words: Diatomaceous earth and zeolite, Ammonia and hydrogen sulfide emission, Pigs

815 Effects of early-weaning versus suckling on the gastrointestinal tract and whole body growth in neonatal pigs. D. Lackeyram^{*1}, M. Z. Fan¹, T. Archbold¹, T. Rideout¹, Y. Gao¹, M. Borysenko¹, A. M. Gibbins¹, E. J. Squires¹, and D. G. Burrin¹, ¹*University of Guelph, Ontario, Canada*, ²*Baylor College of Medicine*.

This experiment is to compare effects of weaning piglets at early age with low-quality corn and soybean meal-based starter diet versus suckling on the gastrointestinal tract and whole body growth. A group of six Yorkshire piglets were weaned with a Phase II starter diet containing corn and soybean meal to meet NRC requirements for CP (26% CP) and amino acids for 10 d from the age of 10 to 22 d. The suckling group of piglets were suckling with access to a creep diet for the same period of time. As expected, the weaning group only had about 28% (48.8±10.2 vs. 177.8±13.4 g/day, n = 6) of body weight gain of the suckling piglet group. The weaning group piglets had much longer small intestine than the suckling group piglets (188.0±4.8 vs. 163.0±7.7 cm/kg BW), suggesting weaning stimulates the elongation of the small intestine in neonatal pigs. There were no differences (P>.05) in the absolute fresh weights of the small intestine (189.9±10.7 vs. 189.4±18.4 g/pig, n=6) between the two groups of piglets. Relative fresh weights of the small intestine were much smaller in suckling (38.2±1.4 g/kg BW) than in the weaning (46.1±3.0 g/kg BW) piglets, indicating that the gut is less efficient in handling nutrient digestion and absorption in support of whole body growth in the weaning piglets than the suckling.

Key Words: Early-weaning and suckling, Growth, Neonatal pigs

816 Effects of early-weaning versus suckling on the gastrointestinal tract and whole body growth in neonatal pigs. D. Lackeyram^{*1}, M. Z. Fan¹, T. Archbold¹, T. Rideout¹, Y. Gao¹, M. Borysenko¹, A. M. Gibbins¹, E. J. Squires¹, and D. G. Burrin¹, ¹*University of Guelph*, ²*Baylor College of Medicine*.

This experiment is to compare effects of weaning piglets at early age versus suckling on the gastrointestinal tract and whole body growth. A group of six Yorkshire piglets were weaned on Phase II starter diet for 10 d from the age of 10 to 22 d. The diets contained corn and soybean meal to meet NRC requirements for crude protein (26% CP) and amino acids. Another group of piglets were suckling from sows and had access to a creep diet for the same period of time. As expected, the weaning group only had about 28% (48.8±10.2 vs. 177.8±13.4 g/day, n=6) of body weight gain of the suckling piglet group. The weaning group piglets had much longer small intestine than the suckling group piglets (188.0±4.8 vs. 163.0±7.7 cm/kg BW), suggesting weaning stimulates the elongation of the small intestine in neonatal pigs. There are no differences (P > .05) in the absolute fresh weights of the small intestine (189.9±10.7 vs. 189.4±18.4 g/pig, n=6) between the two groups of piglets. Relative fresh weights of the small intestine is much smaller (P<.05) in suckling (38.2±1.4 g/kg BW) than in the weaning (46.1±3.0 g/kg BW) piglets. These results suggest that the gut is less efficient in handling nutrient digestion and absorption to support whole body growth in the the weanling than in the suckling piglets.

Key Words: Early-weaning and suckling, Growth, Neonatal pigs

817 Postprandial kinetics of supplemental K-difformate in duodenal digesta of weaned piglets. Z. Mroz^{*1}, A.W. Jongbloed¹, and M. Overland², ¹*Institute for Animal Science and Health, Lelystad, Holland*, ²*Norsk Hydro ASA (Hydro Nutrition), Oslo, Norway*.

An experiment was conducted to measure the postprandial kinetics of supplemental K-difformate (an alternative to in-feed antibiotics) in the small intestine of weaned piglets. Six crossbred sib gilts initially 10 kg BW and 34 d of age were fitted with T-duodenal cannula, and fed a cereal-soybean meal based diet with graded doses of K-difformate (.0, .9, and 1.8%) according to a double 3 x 3 Latin square design. Feeding level was 2.5 MJ ME/kg metabolic BW. Daily rations were given in two meals (water:feed ratio of 3:1). Duodenal digesta were sampled at 0, 30, 60, 90, 120, 180 and 240 min. after feeding. The piglets had no clinically manifested health problems related to the duodenal T-cannulation and(or) doses of K-difformate. The contents of formate in the duodenal digesta were linearly increasing (P<.001) with increasing doses of K-difformate, irrespective of the sampling time. Luminal amounts of formate varied from 79 to 93% of the consumed formate from K-difformate. Due to the greater concentrations of formate in digesta, also the luminal pH has been decreasing by .3 to .5 units (P<.05), particularly up to 65 min after feeding. Concentrations of K in the duodenal digesta were positively correlated with increased K intake from K-difformate. The postprandial amount of luminal K gradually increased up to 3 times of its dietary intake, presumably due to a meaningful contribution of endogenous K from the outflow of pancreatic juice into the duodenum. Postprandial flow patterns of Co (a marker for liquid phase in digesta) were found similar among the treatments, what implies that K-difformate did not affect the gastric emptying patterns. Trypsin activity in the duodenal digesta was similar among the treatments. In conclusion, we found that K-difformate did not affect gastric emptying patterns, and its composite formate entered into the small intestine. Thereby, colonisation of epithelial cells by enterotoxigenic bacteria could be inhibited.

Key Words: Piglet, K-difformate, Kinetics

818 Evaluating variable feed energy levels for grow-finish pigs. C.T. Herr^{*}, D.C. Kendall, K.A. Bowers, and B.T. Richert, *Purdue University, West Lafayette, IN*.

One-hundred fifty-nine pigs, 84 barrows (B) and 75 gilts (G), with an initial weight of 29.0 kg were allotted by sex and weight to evaluate the effects of dietary metabolizable energy (ME) concentrations on growth performance and carcass traits. Pigs were fed one of four dietary treatment sequences ad libitum for 97 days. Diet sequences consisted of four phases (29-54, 54-74, 74-98, 98-115 kg, respectively) with lysine levels consistent through all four dietary energy treatments (total lysine

1.1, .9, .75, and .6%, phase 1-4, respectively) and varying energy levels; diet sequence 1 (Corn-soy + fiber) containing 3.20, 3.20, 3.22, 3.12 Mcal/kg, diet 2 (corn-soy) 3.31, 3.32, 3.33, 3.23 Mcal/kg, diet 3 (corn-soy + 3.5% fat) 3.47, 3.49, 3.50, 3.34 Mcal/kg, and diet 4 (corn-soy + 7% fat) 3.63, 3.65, 3.66, 3.51 Mcal/kg of feed. Pigs were weighed at the end of each phase and total feed consumed was recorded to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). Carcass data were obtained at a commercial slaughter facility. Increased levels of ME increased in overall (0-97 d) ADG (846, 872, 897, 917 g/d respectively; linear, $P < .001$) and G:F (.32, .34, .36, .39 respectively; linear, $P < .001$). Overall ADFI decreased as ME levels increased in the diet (2.60, 2.57, 2.49, 2.35 kg/d respectively; linear, $P < .001$). Final BW increased with increasing ME (111, 114, 116, 118 kg, respectively; linear, $P < .001$). Overall, ADG and ADFI were higher in B than G (921 vs. 845 g/day; 2.62 vs. 2.4 kg/day, respectively, $P < .001$). As ME was increased in the diet, backfat depth increased (18.9, 18.7, 20.9, 22.4 mm respectively; linear, $P < .001$). B had greater backfat thickness than G (21.84 vs. 18.57 mm; $P < .001$). Percent lean decreased as ME increased (54.6, 54.6, 54.1, 53.5%; linear, $P < .02$) and G had a higher percent lean than B (54.8 vs. 53.6%; $P < .001$). During phase 1, all pigs had similar ADFI ($P > .75$), consequently, ADG increased linearly with increasing ME/kg ($P < .001$). However, during phases 2, 3, and 4, pigs adjusted ADFI relative to dietary energy concentration to achieve similar ME intakes ($P > .46$). Based on growth rate, optimal dietary lysine:energy ratios for phase 1, 2, 3, and 4 were 3.00, 2.50, 2.25, and 1.80 g Lysine/Mcal ME, respectively.

Key Words: Pigs, Grow-finish, Dietary energy

819 Evaluating inclusion levels of soybean hulls in finishing pig diets. K. A. Bowers*, C. T. Herr, T. E. Weber, D. Smith, and B. T. Richert, *Purdue University, West Lafayette, IN.*

One hundred sixty-five pigs (85 barrows (B) and 80 gilts (G); initial BW=70.8 kg) were used to evaluate feeding varying levels of soybean hulls (SH) added to corn/soybean meal diets for finishing pigs. Pigs were blocked by weight (6 to 7 pigs/pen) and phase fed one of five dietary treatments for eight weeks: 1) 0% SH; 2) 3% SH; 3) 6% SH; 4) 9% SH; and 5) 9% SH with added fat to make near-isocaloric to diet 1. Diets were formulated for the first 4 wk (P1), at .56% App. Dig. Lys and Kcal ME/kg as follows: diet 1) 3380; 2) 3334; 3) 3288; 4) 3244; 5) 3385, and the second 4 wk (P2), at .48% App. Dig. Lys and Kcal ME/kg; 1) 3394; 2) 3349; 3) 3303; 4) 3257; 5) 3398. Diets 1 through 4 were compared for linear, quadratic, and cubic effects of SH concentrations and diet 5 was contrasted with diet 1 for effects of SH in a similar energy density diet. Average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F) were determined at 14-day intervals. In P1, ADG and ADFI increased with diet 2 and then decreased with increasing concentrations of SH (ADG; 930, 993, 839, 871, and 971 g/d, respectively; lin., $P < .04$; cubic, $P < .01$; ADFI; 2.98, 3.07, 2.72, 2.88, and 2.92 kg/d, respectively; cubic, $P < .04$). During P1, pigs fed diet 5 had greater G:F than pigs fed diet 1 (.337 vs. .310; $P < .005$), however, no differences were observed in ADG in P1, P2, or overall between pigs fed diets 1 and 5. Pigs fed increasing levels of SH had decreasing G:F (.279, .274, .271, .252, and .275, respectively; linear, $P < .03$) in P2. Over the entire 8 wk, increasing levels of SH decreased ADG (921, 943, 857, 866, and 930 g/d, respectively; lin., $P < .01$; cubic, $P < .03$), G:F (.294, .298, .288, .276, and .302, respectively; lin., $P < .02$) and final BW (122.5, 123.8, 118.3, 119.3, and 122.9 kg, respectively; lin., $P < .01$; cubic, $P < .03$). There were no dietary effects on backfat thickness, however, loin depth increased in pigs fed diet 2 and then decreased with increasing levels of SH (quad. $P < .009$). B had greater fat depth ($P < .001$), lower loin depth ($P < .0001$) and % lean ($P < .001$) than G. These results indicate that adding 3% SH may improve growth performance of late finishing pigs. However, inclusion rates greater than 3% SH without increasing ME/kg results in significant reductions in ADG and G:F.

Key Words: Soybean hulls, Pigs, Growth

820 Digestibility of nutrients in diverse soybean genotypes when fed to growing pigs. D. J. Lee*¹, J. D. Hancock, R. H. Hines, J. M. DeRouchey, C. A. Maloney, D. W. Dean, H. Cao, and J. S. Park, ¹*Kansas State University, Manhattan.*

Four crossbred barrows (60 kg average BW) were fitted with T-cannulas at the distal ileum and used in a 4 x 4 Latin square to determine the digestibility of nutrients in various extruded soybean preparations.

Cornstarch-based diets were formulated to 19% CP with: 1) soybean meal (46.5% CP); 2) low trypsin inhibitor soybeans; 3) low oligosaccharide soybeans; and 4) high oleic acid soybeans. Urease activities of the extruded soybeans ranged from .02 to .03 DpH indicating that proper heat processing was accomplished. Apparent digestibilities for DM, N, and lys were not different ($P > .70$) among the soybean meal and dry-extruded whole soybean (DEWS) preparations. Digestibility of fatty acids was greater for the DEWS preparations than for the soybean meal ($P < .001$), but no differences were detected among the various DEWS treatments ($P > .35$). Our data indicate that digestibility of nutrients was similar among soybean meal and DEWS made from low trypsin inhibitor, low oligosaccharide, and high oleic acid soybean genotypes.

Item	Soy bean meal	Low trypsin inhibitor	Low oligo-saccharide	High oleic acid	SE
DM dig, %	78.6	78.4	79.2	77.4	1.0
N dig, %	82.0	80.9	82.1	82.5	1.1
Lys dig, %	85.8	86.2	86.0	86.8	1.0
True lys dig, %	88.8	89.2	89.1	89.9	1.0
Fatty acid dig, %	76.4	90.2	91.2	89.0	1.5

Key Words: Pig, Soybeans, Digestibility

821 Digestibility of nutrients in food-grade sorghum for finishing pigs. D. W. Dean*, J. D. Hancock, R. H. Hines, and D. J. Lee, *Kansas State University, Manhattan.*

Six crossbred barrows (average initial BW of 73 kg) were used in a 6 x 6 latin square to determine digestibility of nutrients in food grade sorghum. Treatments were: 1) corn; 2) bronze-pericarp sorghum (Pioneer 8500); 3) heterowaxy food-grade (white pericarp/tan plant) sorghum (NC+ 7W97); and 4 and 5) two food-grade sorghums with normal starch type (Cargill 888Y and Jowar 1). The cereals were hammermilled through a 3.2-mm screen and fed as 95.5% of a diet with vitamins, minerals, and synthetic amino acids added to meet or exceed NRC (1998) recommendations. Apparent digestibilities of DM ($P < .01$), N ($P < .001$), and GE ($P < .01$), and percentage N retention ($P < .01$) and ME ($P < .01$) were greater for pigs fed corn compared to those fed sorghum. The heterowaxy sorghum had greater digestibility of DM ($P < .01$) and ME ($P < .01$) than the food-grade genotypes with normal starch type but these effects were caused primarily by the low digestibilities of DM and energy for Cargill 888Y (Jowar 1 vs 888Y, $P < .001$). However, none of the food-grade sorghums were superior to the bronze pericarp sorghum for utilization of energy or N ($P > .2$). Thus, our results suggest that sorghums are lower in digestibility of energy and N compared to corn and that nutrient digestibilities among the bronze and white pericarp sorghums were similar.

Item	Corn	Pioneer 8500	NC+ 7W97	Cargill 888Y	Jowar 1	SE
DM digestibility, %	87.8	87.1	87.2	84.3	87.0	.4
DE, %	87.6	86.3	86.3	83.5	86.8	.5
ME, %	86.2	85.0	85.2	82.1	85.8	.5
ME, Mcal/kg	3.28	3.18	3.21	2.97	3.20	.02
N digestibility, %	83.9	75.2	76.6	73.9	76.1	1.0
Biological value, %	77.6	73.7	73.2	75.7	70.9	2.4
N retention, %	65.1	55.5	56.0	56.0	53.9	2.2

Key Words: Sorghum, Food-grade, Pig

822 Effect of high oil corn and method of substitution on grow-finish pig performance and dust production. R.C. Thaler* and S.H. Pohl, *South Dakota State University, Brookings.*

Effect of high oil corn and method of substitution on grow-finish pig performance and dust production.

Two trials involving a total of 200 gilts averaging 22.7 kg were conducted to determine the effect of high oil corn (HOC) on performance and dust production. Pigs were housed in mirror-image rooms with separate mechanical ventilation systems with dust levels measured every 2 weeks. A 3-phase feeding program was used in both trials with meal diet switches made at pig weights of 41 and 77.3 kg. Lysine levels by phase in the corn diets were 1.00, .85, and .75%, respectively. At a final weight of 109 kg, all pigs were ultrasonically scanned for 10th rib BF and LMA. In trial 1, the treatments were either normal corn (C) or HOC (LB)

replacing normal corn on a lb-for-lb basis. In the grower phase, pigs fed HOC tended to gain faster ($P < .07$) and were more efficient ($P < .04$) than pigs fed the C diet. There were no differences in performance in the finisher 1, finisher 2, or overall periods, nor were there differences in BF. However, there was a tendency ($P < .075$) for pigs fed HOC diets to have smaller LMA. The mean dust concentrations in the HOC room was 40% less than the levels in the C room. In trial 2, the treatments were the same as in trial 1 plus a third treatment in which HOC replaced corn on a constant lysine:calorie ratio (L:C). The ratios for the 3 phases were 3.05, 2.60, and 2.27 g lysine/mcal ME, respectively. In the grower phase, L:C pigs gained faster ($P < .05$) than pigs consuming LB diets, and were more efficient ($P < .01$) than pigs fed the other 2 diets. No differences were observed in the finisher 1 or 2 phases. In the overall period, pigs fed L:C ate less feed ($P < .08$) than C pigs, and pigs fed wither of the HOC diets were more efficient ($P < .05$) than pigs were C diets. No differences were observed in BF, but feeding L:C diets tended to result in larger LMA when compared to LB diets ($P < .16$). Mean dust levels were reduced 37% in the HOC room. Thus, HOC results in a 40% reduction in dust levels, and needs to be incorporated into diets on a constant lysine:calorie basis.

Key Words: Pigs, High Oil Corn, Dust

823 Nutrient digestibilities of intact and insect damaged high oil corn and commercial corn fed to growing pigs. R. F. Gilliam*, C. S. Darroch, and K. R. Robbins, *University of Tennessee, Knoxville.*

The objective of the trial was to determine the nutritive values of damaged high oil corn (DHOC), undamaged high oil corn (UHO) and commercial corn (NC). Two groups of 12 crossbred barrows, average BW of 32.1 kg, were placed in metabolism crates in a RCBD to determine energy and protein digestibilities. In each 10-d feeding period (5 d adaptation, 5 d total collection), pigs were fed the test grain as the only source of protein and energy in the diet. Vitamins and minerals were supplied to meet NRC (1998) requirements. Insect damaged HOC had lower ($P < .0001$) 1000 kernel weights, 238.1 g (± 3.32 ; $n=5$) when compared to UHO (355.4 g) and NC (272.0 g). Compared to UHO, insect damaged HOC had fewer intact kernels (50.8% vs 77.0%, $P < .0001$), more insect damaged whole kernels (15.9% vs 5.0%, $P < .0001$), more fragmented kernels (32.3% vs 17.6%, $P < .0001$) and more chaff (0.9% vs 0.4%, $P = .0028$). NC had the greatest percentage of intact kernels (87.9%), and the lowest percentages of damaged whole kernels (1.5%) and fragmented kernels (10.2%). Despite differences in quality, UHO and DHOC had higher GE values (3866 kcal/kg and 4081 kcal/kg, respectively) than NC which averaged 3562 kcal/kg. UHO had the highest level of crude protein (9.1%), DHOC was intermediate (8.9%) and NC had the lowest crude protein level (7.6%). Final pig live BW, adjusted for initial BW were not different among treatments ($P = .8692$) but pigs in the second replication were heavier ($P = .0168$) than those in the first replication. The coefficient for apparent fecal protein digestibility was highest (85.2%) for UHO. DHOC had a lower ($P = .0464$) coefficient for protein digestibility (81.3%, ± 1.10). The apparent fecal protein digestibility of NC was intermediate to those of UHO and DHOC. Digestible energy differed among treatments ($P = .0001$) and averaged 3658.42 kcal DE/kg, 3788.72 kcal DE/kg and 3314.21 kcal DE/kg for UHO, DHOC and NC respectively. The results of this experiment suggest that insect damage to HOC lowers protein quality and availability, but has little impact on digestible energy levels. HOC even when damaged may be used as a replacement for commercial corn in diets for growing pigs.

Key Words: High oil corn, Nutrient digestibility, Growing pigs

824 Effect of creatine monohydrate on finishing pig growth performance, carcass characteristics, and meat quality. B. W. James*, R. D. Goodband, J. A. Unruh, M. D. Tokach, J. L. Nelssen, P. R. O'Quinn, and B. S. Andrews, *Kansas State University, Manhattan.*

Growth performance, carcass characteristics, and meat quality were evaluated from 320 pigs (PIC C22 \times L326) fed either a control diet (.75% lysine) or diets containing added creatine monohydrate (CMH). Pigs (initially 53.5 kg) were sorted by weight, gender, and ancestry in a randomized complete block design and allotted to one of four dietary treatments with eight replicates. Pigs were fed a sorghum-soybean meal

diet until 30-d preharvest (87.2 kg) when dietary treatments were initiated. Experimental treatments consisted of: 1) a control diet; 2) control diet with 3 g CMH/pig/d for 30-d (maintenance); 3) 25 g CMH/pig/d for 5-d followed by 3 g CMH/pig/d for the next 25-d (early load); 4) or 25 g CMH/pig/d 5-d before slaughter (late load). Average market weight was 112.4 kg. Feeding CMH did not affect ($P > .10$) ADG, ADFI, or gain:feed ratio (G:F) during the 30-d supplementation period. Average back fat, tenth rib fat depth, longissimus muscle area, and percentage lean were not affected ($P > .25$) by feeding CMH. Visual color and marbling scores were not affected ($P > .20$) at 24-h or 14-d postmortem; however, the mean firmness score of all pigs fed CMH was greater ($P < .05$) at 24-h and 14-d postmortem than pigs fed the control diet. Longissimus muscle percentage moisture, protein, and lipid and 14-d postmortem loin purge loss and Warner-Bratzler shear force values were not affected ($P > .21$) by treatment. Longissimus muscle drip loss percentage at 24-h postmortem was less ($P < .05$) for pigs fed maintenance and late load CMH compared to pigs fed early load CMH (4.06, 4.15, vs 5.76%). Maintenance CMH pigs also tended to have less ($P < .09$) drip loss than control pigs (4.06 vs 5.31%). At 14-d postmortem, the mean of pigs fed CMH had less ($P < .06$) drip loss compared to control pigs. These results suggest that added CMH does not affect finishing pig growth performance but may increase longissimus muscle firmness and decrease drip loss at 14-d postmortem.

Key Words: Pigs, Creatine, Meat Quality

825 Effects of feeding supra-nutritional levels of vitamin E on pork quality in two different genotypes. J. L. Hasty*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh.*

The objective of this study was to examine the effects of feeding supra-nutritional levels of vitamin E on pork quality of different genotypes. Pigs ($n=240$) with an average initial BW of 87 kg, were blocked by weight and randomly assigned to one of ten treatments (8 pens/trt, 3 pigs per pen) in a 2 \times 5 factorial arrangement. Factors included: 1) genotype, (Berkshire \times PIC as superior meat quality breed and Hampshire \times PIC as poor meat quality breed) and 2) supplemental levels of vitamin E (0, 75, 150, 300 and 600 mg/kg). Animals were fed standard corn and SBM based diets containing 2.5% fat, 0.83% lysine and 15 mg/kg vitamin E for 6 weeks. Biopsies of the longissimus dorsi (LD) were obtained at the initiation of the experiment, d 21, and d 42 of supplementation. Fluid loss and pH of the fluid from biopsy samples were used as indicators of pork quality and were not affected by vitamin E supplementation ($P > .10$). However, fluid loss was greater ($P < .07$) in Hampshire pigs (51.9 vs. 47.7%) and pH of the fluid was greater ($P < .10$) in these pigs compared to Berkshire pigs (6.40 vs. 6.35). Pigs were slaughtered at a commercial facility after the 6 week experimental period and loin samples were obtained 24 hr post-mortem. Drip loss was greater ($P < .001$) in Hampshire pigs compared to Berkshire pigs (92.9 vs. 66.3 mg fluid accumulated on filter paper). Muscle vitamin E concentration increased linearly ($P < .001$) from 2.02 to 5.92 mg/kg for pigs fed 0 to 600 mg/kg of vitamin E. Concentration of vitamin E in muscle was greater in Berkshire pigs compared to Hampshire pigs when 75 mg/kg of vitamin E was fed (4.72 vs. 3.76 mg/kg). In summary, pre-slaughter muscle biopsy fluid loss appeared to be an accurate indicator of post-slaughter drip loss. Results of the study further demonstrate that differences in fresh pork quality exist between genotypes (as measured by drip loss), but did not appear to be improved by vitamin E supplementation.

Key Words: Vitamin E, Genotype, Pork Quality

826 Effects of increasing L-lysine HCl on growth performance and carcass characteristics of gilts from 27 to 120 kg. M. De La Lata*, S.S. Dritz, M.D. Tokach, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,200 gilts (PIC C22 \times 337) with an initial weight of 29 kg were used in a 116-d growth trial to determine the effect of increasing L-lysine HCl in corn-soybean meal based diets on growth performance and carcass characteristics. Pigs were housed in a fully slatted commercial research facility and allotted to one of 8 dietary treatments in a randomized complete block design with 25 pigs/pen and 6 pens/treatment. The dietary treatments were fed in four phases and consisted of a positive control diet with no added L-lysine HCl and 6 increasing levels of L-lysine HCl (.05, .10, .15, .20, .25, and .30%) replacing the lysine

provided by soybean meal. A negative control treatment with no added L-lysine HCl was formulated to contain .10% less total lysine than the other treatments to ensure dietary lysine was not above required levels. For the overall experiment, ADG and G/F decreased in a quadratic fashion ($P < .05$) by increasing L-lysine HCl in the diet. Treatment did not influence ($P > .70$) ADFI. The response was similar for every phase. Fat depth increased (linear $P < .01$) and loin depth, percent lean, and fat free lean index (FFLI) decreased by increasing L-lysine HCl in the diet. The results of this experiment indicate that no more than .15% L-lysine HCl should replace lysine from soybean meal in a corn-soybean meal based diet to avoid deficiencies of other amino acids.

Item	Neg.	L-Lys HCl, %							P <	CV
		0	.05	.10	.15	.20	.25	.30		
ADG, g	717	798	807	794	798	744	717	708	.01 ^a	3.2
G/F	.353	.387	.390	.388	.391	.361	.356	.356	.01 ^a	2.6
BF, mm	17.8	16.8	16.9	17.2	17.1	17.6	18.2	17.8	.01 ^b	4.7
Lean, %	54.8	55.8	55.6	55.3	55.5	55.3	54.7	54.8	.01 ^b	1.0
FFLI	50.1	50.5	50.5	50.3	50.4	50.1	49.8	50.1	.01 ^b	.78

^aQuadratic effect.

^bLinear effect.

Key Words: Lysine, Corn, Finishing Pigs

827 Growth performance of gilts fed low-crude protein diets supplemented with crystalline amino acids including valine, isoleucine, and histidine. J. L. Figueroa*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

Two experiments were conducted to determine the fifth-limiting amino acid in a low-crude protein, corn-soybean meal diet. In each experiment, thirty-six gilts (initial weight 19.5 and 21.9 kg, respectively) were individually penned and fed one of six diets in a randomized block design for 35 d. Diets containing 16% CP (positive control), 12% CP (neutral control), and 11% CP (negative control) were used in each experiment. In Exp. 1, the 11% CP diet was supplemented with isoleucine (Ile), valine (Val), or Ile + Val to concentrations equal to those in the 16% CP diet. In Exp. 2, the 11% CP diet was supplemented with histidine (His), His + Val, or His + Val + Ile. All low-CP diets were supplemented with lysine, tryptophan, threonine, and methionine to provide the same concentrations, on a total basis, as those in the 16% CP diet. Gilts were allowed ad libitum access to feed and water. In Exp. 1, Ile supplementation of the 11% CP diet decreased growth performance and backfat thickness ($P < .05$). Valine supplementation did not affect growth performance ($P > .05$). However, the addition of Ile + Val resulted in ADG, ADFI, and longissimus muscle areas that were similar to the 12% CP and 16% CP diets ($P > .05$). Plasma urea nitrogen (PUN) concentrations were reduced as CP concentration was reduced ($P < .01$), but there was no further effect with addition of Ile and/or Val ($P > .05$). In Exp. 2, supplementation of the 11% CP diet with His decreased ADG by 7% and ADG/ADFI by 3%, but the decreases were not significant ($P > .30$). Supplementation of His + Val increased ADG ($P < .05$) and tended to increase ($P < .10$) ADFI and ADG/ADFI. Reduction in CP concentration reduced PUN concentration ($P < .01$). There were no differences among all low-CP diets in PUN concentration ($P > .05$). These data indicate that supplementation of Val in combination with Ile or His improved growth rate of pigs fed an 11% CP corn-soybean meal diet. Neither Ile, Val, nor His alone resulted in beneficial effects.

Key Words: Pigs, Amino Acids, Crude Protein

828 Influence of energy and lysine concentration on performance and carcass yield of heavy weight pigs. M. A. Latorre*¹, P. Medel¹, A. Fuentetaja², E. Gómez³, and G.G. Mateos¹, ¹Dpto Producción Animal, Universidad Politécnica de Madrid, ²COPESE S.A., Segovia, ³Centro de Pruebas de Porcino, Junta de Castilla y León.

A total of 192 Pietrain*Large White x Large White*Landrace pigs were used to study the influence of dietary energy and lysine concentration on performance of heavy weight pigs. They were fed a common diet (2,300 kcal NE/kg and 0.97% lysine) from 20 to 80 kg and then their respective experimental diets to 120 kg of live weight. There were six diets arranged as a factorial 2x3 with two levels of dietary net energy (2,300 vs 2,415 kcal/kg) and three levels of total lysine (0.65, 0.70 and 0.75%). Each treatment was replicated 8 times (2 females and 2 castrated males caged together). Pigs fed high energy diets grew faster and transformed feed into gain more efficiently than pigs fed low energy diets (977 vs 927 g/d and 3.26 vs 3.45 g/g; respectively, $P < 0.05$). Feed intake was not affected by the energy concentration of the diet. Increasing the level of lysine up to 0.65% improved growth and feed conversion (979 vs 897 g/d and 3.25 vs 3.55 g/g, respectively; $P < 0.01$) but no additional improvement was detected between 0.70 and 0.75%. Castrated males grew faster (989 vs 928 g/d; $P < 0.01$). Neither energy concentration nor lysine content of the diet influence carcass yield ($P > 0.05$). At 120 kg body weight castrated males and females had similar killing out percentage (76.3 vs 75.9%; $P > 0.05$). It is concluded that growth and feed conversion of pigs of 120 kg were improved when the energy concentration of the diet was increased from 2,300 to 2,415 kcal NE/kg and that 0.70% of lysine was sufficient to optimize performance traits at this weight. Killing out percentage was not modified by any of the treatments studied.

Key Words: Heavy weight pigs, Lysine, Net energy

829 Modeling of dietary lysine requirements for pigs fed Ractopamine. A. P. Schinckel*¹, L.E. Watkins², D. J. Jones², and M. E. Einstein¹, ¹Purdue University, West Lafayette, IN, ²Elanco Animal Health, a Division of Eli Lilly and Co., Greenfield, IN.

Ractopamine (RAC) has been approved to be fed to market pigs at levels (RL) from 5 to 20 ppm. RAC increases empty body protein accretion (PA, 24%), fat-free lean growth rate (34%) and reduces feed intake (FI 5.3%) when fed at 20 ppm for the last 40.8 kg live weight gain. The response to RAC is greatest the first 21 d or 20 kg live weight gain on RAC, after which time, the RAC response decreases. The relative RAC response was modeled as $RR = 1.408 \exp [0.050224 w - (1.09164/w) - (.002607w^2)]$ where w is live weight gain (kg) on RAC. This RR function is based on data in which barrows ($N=142$) and gilts ($N=143$) were individually scale fed two levels of RAC (0 vs. 44.7 mg/d; Williams et al. 1994). The RAC response is affected by RL. The increase in PA (g/d), due to RAC, was modeled as $.24 (RL/20)^{.50}$ times the control PA at each live weight. The reduction in FI (kg/d) was modeled as $.053 (RL/20)^{.66}$ times the control FI at each live weight. The lysine content of empty body protein for pigs fed RAC was modeled as $.068 + (.002 RR \times [RL/20]^{.50})$. Predicted daily lysine requirements increased rapidly as RR increased. Maximum RR was achieved at 11.1 kg weight gain on RAC. After 22 d on test, RR decreased, and control PA decreased, resulting in decreased daily lysine requirements. The predicted percent lysine required (PLY) for the first 21 d or 20 kg live weight gain on RAC are 41.7% greater than required by pigs not fed RAC. The PLY after 21 d or 20 kg live weight gain on RAC is 21.5% greater than that required by pigs not fed RAC. The predicted percent increases in PLY for pigs fed 10 ppm RAC are 28.1 and 14.4% for the two feeding periods. The predicted percent increase in PLY is 19.3 and 9.7% for pigs fed RAC at the 5 ppm level. The results indicate a two-phase feeding strategy: feed higher percent lysine diets for the first 21 d or 20 kg live weight gain on RAC and reduced lysine levels after 21 d or 20 kg of RAC feeding.

Key Words: Ractopamine, Pigs, Lysine

PHYSIOLOGY

830 Effect of the flavonoid catechin or epicatechin on the motility of extended cooled equine spermatozoa. C. A. Woodward*, S. A. Ericsson, P. H. Phurdy, and M. D. Fox, Jr., *Sul Ross State University, Texas, TX.*

The objective of this study was to determine if either of the flavonoids catechin or epicatechin were capable of maintaining the motility of extended cooled stallion spermatozoa. Semen samples were collected from 7 stallions using a teaser mare, phantom mount and artificial vagina. Samples were aliquoted (100 μ l) into replicates of 3 and placed into Kenney's non-fat dried skim milk extender (400 μ l) containing 0 (control), 25, 50, 75 or 100 μ M catechin or epicatechin. Extended samples were cooled and maintained at 5°C prior to microscopic analysis (250X) of percent sperm motility at 24, 48, 72 and 96 hr. Percentage data for motility were arcsine transformed and analyzed using ANOVA for differences among levels of flavonoid. The percentage of motile spermatozoa in the extender containing no flavonoid (mean \pm SD: 23% \pm 14) at 48 hr was significantly lower than those containing 25 μ M (31% \pm 18, $P < 0.004$), 50 μ M (34% \pm 18, $P < 0.0004$), 75 μ M (34% \pm 17, $P < 0.0001$) or 100 μ M (31% \pm 19, $P < 0.005$) of catechin. Samples treated with 25 μ M (33% \pm 16, $P < 0.0001$), 50 μ M (35% \pm 17, $P < 0.0001$), 75 μ M (37% \pm 20, $P < 0.0001$) and 100 μ M (31% \pm 17, $P < 0.007$) of epicatechin had significantly higher percentages of motile spermatozoa than the extender containing no flavonoid. The extender without flavonoids at 72 hr contained fewer motile spermatozoa (15% \pm 11) than extenders with 50 μ M (24% \pm 15, $P < 0.008$) or 75 μ M (20% \pm 13, $P < 0.05$) of catechin or 50 μ M (26% \pm 16, $P < 0.002$) or 75 μ M (22% \pm 18, $P < 0.03$) of epicatechin. Likewise, the control (8% \pm 8) at 96 hr contained fewer motile spermatozoa than extenders with 25 μ M (12% \pm 8, $P < 0.008$), 50 μ M (15% \pm 11, $P < 0.003$), 75 μ M (12% \pm 10, $P < 0.01$) or 100 μ M (11% \pm 8, $P < 0.009$) of catechin and 25 μ M (13% \pm 11, $P < 0.002$) or 50 μ M (15% \pm 13, $P < 0.006$) of epicatechin. These results suggest that there is a dose and time related effect of catechin and epicatechin on the motility of extended equine spermatozoa.

Key Words: Flavonoids, Sperm, Equine

831 The effect of 2-bromo-ergocriptine on LH secretion in mature breeding stallions. K. Bennett-Wimbush*¹ and D. Keisler², ¹*Ohio State University Agricultural Technical Institute, Wooster, Ohio,* ²*University of Missouri, Columbia, Missouri.*

Five mature stallions (ages 4-20) were used in this paired t-test experiment to determine the effect of daily administration of the dopamine agonist, 2-bromo-ergocriptine on LH secretion patterns during the physiological breeding season. Prior to treatment, stallions were fitted with indwelling jugular catheters at approximately 0800 hour. After an initial 30 minute adjustment period, blood samples were collected every 15 minutes for 8 hours into sodium heparinized Vacu-tainer tubes. Catheters were removed after this collection period. Samples were immediately placed on ice and held until the blood was centrifuged and plasma was decanted off. Plasma was stored at -10°C until it was assayed for LH. Following this pre-treatment bleed, stallions were treated with .08 mg/kg metabolic body weight (kg^{.75}) of 2-bromo-ergocriptine, IM, twice daily for 30 days. On day 28 of treatment, jugular catheters were again used to repeat the intensive bleeding procedure as described earlier. Plasma prolactin concentrations were determined from daily samples collected one week prior to treatment and again during week 4 of treatment. Prolactin and LH concentrations were determined using homologous and heterologous radioimmunoassays respectively. LH pulse frequency, amplitude and means were determined using PC PULSAR. Differences between pre-treatment and post-treatment LH pulse frequency, amplitude, means and prolactin were analyzed using GLM, SAS. Mean plasma prolactin decreased ($p < .01$) from 7.9 ng/ml before treatment to 3.6 ng/ml after treatment. There was no change in mean LH, LH pulse frequency or average amplitude following treatment with bromocriptine. Before treatment LH pulse frequency, average pulse amplitude and mean LH was 2.9 \pm .7 pulses/8 hr., 2.9 \pm 1.0 ng/ml and 5.9 \pm 1.0 ng/ml respectively vs. 2.4 \pm .9 pulses/8 hr., 1.5 \pm 1.3 ng/ml and 3.8 \pm 1.3 ng/ml following 28 day administration of bromocriptine. In conclusion, the administration of bromocriptine decreased plasma prolactin, however neither the decrease in prolactin or alteration of the

dopaminergic system resulted in any change in the LH secretion patterns in mature stallions.

Key Words: Stallion, Prolactin, LH

832 Effects of group size and bull-to-heifer ratio on sexual behavior, and concentrations of LH and testosterone in yearling beef bulls. R.D. Smith*, D.B. Imwalle, A.L. King, and K.K. Schillo, *University of Kentucky, Lexington, KY.*

We tested the hypothesis that expression of sexual behavior in bulls is dependent on both the number and type (male and female) of cattle present during behavior tests. Eighteen Black Angus bulls were halter broken and assigned randomly to one of three treatments at approximately 12 months of age. In treatment A, a bull was tested with one heifer. In treatment B, a bull was tested in the presence of three heifers. In treatment C, a bull was tested in the presence of three heifers and two other bulls. Each bull was subjected to all treatments. Order of treatments was random for each bull. Heifers were ovariectomized and injected with 2 mg estradiol benzoate in order to induce estrus at the time of testing. During testing, heifers and bulls were allowed to roam freely in a paddock. Test periods lasted 15 min, during which the following traits were recorded: number of successful and aborted mounts, Flehmen responses, chin rests, and ejaculations. Blood samples were collected by jugular venipuncture 2 min before and 2 min after testing and analyzed for LH and testosterone. Number of aborted mounts for treatment A was less than ($P < .05$) those for treatments B and C. Expressions of other behaviors were not affected by treatment ($P > .1$). Neither LH nor testosterone were affected by treatments ($P > .1$). However, between 2 min before and 2 min after testing, testosterone decreased in treatments A and B, but increased in treatment C ($P < .05$). Neither LH nor testosterone was correlated with any of the behavioral traits ($P > .1$). Overall, the social conditions tested in this experiment did not dramatically alter sexual behavior in bulls.

Key Words: Sexual behavior, LH, Testosterone

833 Peripubertal testicular characteristics in various hair sheep and meat goat breeds. B. L. Sayre* and S. Wildeus, *Virginia State University.*

Reproductive organ weights and histomorphometric dimensions were evaluated in peripubertal, co-raised ram lambs (Katahdin - KA and Barbados Blackbelly - BB; 5/breed) and bucklings (Myotonic - MY, Nubian - NU, Pygmy - PY, and Spanish - SP; 6/breed) recruited from a December-born crop, weaned at 8 weeks of age, and fed for moderate growth. Scrotal content was collected at necropsy at 6 mo of age, after determination of BW and scrotal circumference (SC). Testicular weight and dimensions, and segmented epididymal weights were recorded. Parts of testicular parenchyma, and epididymal segments were fixed and processed for histology (H+E staining) to determine seminiferous and epididymal tubule diameter and epithelial height. Statistical comparisons were performed between species and among breeds within species. Final BW and SC were greater ($P > .001$) in hair sheep than goats (32.8 vs 24.7 kg; 25.9 vs 20.8 cm, respectively), with KA heavier ($P > .001$) and a greater ($P > .05$) scrotal circumference than BB, while goats breeds differed in BW ($P < .001$), but not SC. Testicular and epididymal weights and dimensions were consistently larger in hair sheep than goats ($P < .01$); there were no differences between KA and BB, however, SP had longer testis ($P < .05$) and NU lower caput epididymal weights ($P < .05$) than the other goat breeds. Two BB and 6 bucklings (representing all breeds) had incomplete seminiferous epithelial development. Seminiferous tubule diameter and epithelial height were not affected by species, however, KA (172 μ m) had a larger ($P < .01$) diameter than BB (150 μ m), and PY had a larger diameter (180 μ m) and height (56 μ m) than the other goat breeds (156 and 51 μ m, respectively). Epididymal tubule diameter was not affected by species or breed within species, whereas epithelial height was greater ($P < .001$) in the cauda region of hair sheep than goats (40 vs 33 μ m, respectively). Data indicated differences between species and breeds within species, independent of species and breed variation in BW.

Key Words: Goat, Sheep, Testis

834 Post-treatment reproductive characteristics of boars fed ractopamine hydrochloride during the finishing period. D. J. Jones^{*1}, D. H. Mowrey¹, W. P. Waitt¹, and W. L. Singleton², ¹Elanco Animal Health, Greenfield, IN, ²Purdue University, West Lafayette, IN.

Thirty-six crossbred (Hampshire × Yorkshire) boars, approximately 17 wk of age at trial initiation, were used to evaluate the effect of feeding ractopamine hydrochloride (R) during the finishing period on subsequent reproductive characteristics. Boars were fed R at 0 (n=18) or 20 ppm (n=18) in an 18% crude protein (CP) corn-soy diet, *ad libitum*, from approximately 67 to approximately 116 kg body weight. A non-medicated 18% CP diet was fed at 2.27 kg/day during the remainder of the trial. Boars were trained to a dummy sow at approximately 33 wk of age and semen was collected twice weekly at approximately 36, 40, and 44 wk of age. Least squares means for selected parameters are shown in the table. Boars fed 20 ppm R had increased (P<0.01) average daily gain and improved (P<0.01) feed to gain ratio during the finisher period with no difference (P>0.05) in daily feed intake. No treatment differences were detected (P>0.05) in the following post-treatment reproductive characteristics: testes volume, total semen volume, fluid volume, sperm concentration, total sperm per ejaculate, sperm motility, percent normal sperm, number of boars which mounted, or number of boars collected. In summary, R fed at 20 ppm to boars during the finisher period caused no adverse effects on subsequent reproductive characteristics evaluated.

Parameters	0 ppm R	20 ppm R	SD
Average Daily Weight Gain, kg	1.05	1.16	0.12
Average Daily Feed Intake, kg	2.83	2.75	0.27
Feed to Gain Ratio	2.73	2.38	0.23
Testes Volume, cm ³	3021	3158	1068.4
Total Semen Volume, ml	233.1	223.8	166.4
Fluid Volume (minus gel), ml	196.4	188.2	138.1
Sperm Concentration (no. cells/ml × 10 ⁸)	3.37	3.53	1.90
Total Sperm/Ejaculate (× 10 ⁹)	62.5	60.5	29.5
Sperm Motility, %	80.0	78.1	9.7

Key Words: ractopamine, boars, reproduction

835 Insemination of lactating Angus cows with sexed sperm. S. P. Doyle¹, K. D. McSweeney^{*1}, J. L. Schenk², R. D. Green¹, and G. E. Seidel, Jr.¹, ¹Colorado State University, Fort Collins, ²XY, Inc., Fort Collins, CO.

Insemination of flow-sorted sperm has been reasonably successful in heifers. The objective was to determine pregnancy rates in lactating beef cows following AI of frozen Y-chromosome-bearing sperm. Sperm were sorted with a flow cytometer/cell sorter on the basis of DNA content, targeting 90% Y chromosome-bearing sperm. Angus cows 2 to 15 y of age and in good body condition were synchronized with GnRH/prostaglandin F_{2a} and inseminated (N=105) 12 or 24 h after detected estrus with the following treatments balanced over 3 Angus bulls and 2 inseminators: 1) unsorted, frozen control (20 × 10⁶ sperm/dose) deposited in the uterine body; 2) sorted, frozen sperm (3 × 10⁶ sperm/dose), half deposited into each uterine horn using a side-opening embryo transfer sheath (sexed:horn); and 3) sorted, frozen sperm (3 × 10⁶ sperm/dose) deposited in the uterine body (sexed:body). The day 60 pregnancy rate for sexed:body (55%) was not different (P>.1) from the frozen control (71%) or sexed:horn (45%); however, there was a difference between the frozen control and sexed:horn (P<.05). There were significant AI sire effects on pregnancy rates (P<.05) which were magnified if only sorted treatments were included (39, 43, and 68% pregnant for sexed sperm from 3 bulls). There were no significant interactions. Sex ratios determined by ultrasound of 2-mo fetuses for the sorted treatments (95% males) were different from the frozen control (53% males; P<.01). Fertility of sorted sperm varied among bulls; when low numbers of sperm are inseminated, practical application of current sexing technology may require identification of bulls whose sperm tolerate the stress of sorting and cryopreservation.

Key Words: Beef cattle, Sex control, Fertility

836 X and Y chromosome specific duplex PCR standardized to quantify sex ratio variation in bulls and boars. J. B. Paul^{*}, A. M. Canal, and J. E. Chandler, *LSU Agricultural Center, Baton Rouge, LA.*

Sex ratio manipulation in farm animals is a tool to increase production and hasten genetic improvement. X and Y-bearing spermatozoa variation between ejaculates has not been clearly defined. This describes a duplex PCR assay standardized to quantify X- and Y-bearing spermatozoa ratio variation in bull and boar. PCR primers were designed for single copy genes specific to the X (factor IX) and Y (SRYB) chromosomes. Individually amplified X and Y products were extracted from agarose gels and quantified at 260 nm. Extract volume containing 1 ng of product was calculated and log diluted from 1 ng to 10 fg. Each dilution was subjected to a duplex PCR reaction with the original primers. Each reaction was duplicated, sampled twice and electrophoresed on agarose gels containing ethidium bromide. Gels were viewed on a UV transilluminator and photographed with a silicon intensified camera capable of detecting 10⁻⁷ lux. Gel were imaged with image analysis software to determine the bands intensity density (IDEN). A dilution that yielded intensities near a grayscale value of 125 were selected as a midpoint for the construction of a standard curve. One hundred percent each product was double the product amount selected as midpoint. Treatment combinations (Rx) on the curve were assigned as X to Y percent product (0:100, 20:80, 40:60, 60:40, 80:20, and 100:0). Duplex PCR was performed with the same primers and the gel images were analyzed in order to quantify varying X and Y template concentrations. Intensity densities were analyzed by multivariate regression methods. Linear combinations (Li) were formed from the maximal variance-covariance eigenvector and the IDENs for the appropriate Rx. Simple linear regression of Li on Rx yielded coefficients of determination for bovine and porcine analyses of 0.90 and 0.71. Bovine and porcine Li slopes were different from zero (P<0.0001). Thus, Li can be used to discriminate between ejaculates based on duplex PCR screening.

Key Words: PCR, Bovine, Sex ratio

837 Cryopreservation of flow cytometrically sorted boar sperm: effects on in vivo embryo development. L. A. Johnson^{*1}, H. D. Guthrie¹, P. Fiser¹, W.M.C. Maxwell², G.R. Welch¹, and W.M. Garrett¹, ¹USDA Beltsville Agricultural Research Center, Beltsville, MD USA, ²University of Sidney, Australia.

Cryopreservation of sorted boar sperm would enhance the feasibility of IVF for producing sexed embryos. Aliquots of neat semen from mature boars were diluted and stained with Hoechst 33342, incubated at 35 C, and sorted at room temperature (SORT) into TEST-Yolk (20%) with out regard to separation of the X and Y sperm populations (Theriogenology 52:1323-1341;1999). Samples were centrifuged, 3% glycerol added, and loaded into .25 ml straws. After cooling the straws were frozen using a controlled rate freezer. Control semen had been frozen previously from another boar using 11% lactose as the freezing extender UN-SORT). Ovulation was controlled in 11 gilts by an altrenogest-PMSG-hCG regime. Gilts were laparotomized at 44 hr post-hCG and inseminated with 200,000 SORT or UNSORT into the isthmus of respective oviducts. Ten gilts were also inseminated in both oviducts using only SORT to determine litter size at term. Gilts (N=11) for embryos were slaughtered and embryos recovered at 43 hr post insemination. The embryos were fixed in 4% paraformaldehyde, and stained with Texas Red-x phalloidin and Hoechst 33342. Confocal laser microscopy was used to visualize actin cytoskeleton and chromatin configuration. A total of 287 oocytes and embryos were evaluated. Cryopreservation and the subsequent thawing of the SORT sperm had a negative impact on fertilization and embryo development compared to UNSORT sperm as indicated by the incidence of sperm penetrated ova and total embryos (41.2 vs 96.5%, P<.001), normal embryos without fragmentation or polyspermy (4.36 vs 10.5%/oviduct, P<.001), incidence of normal embryos (55.4 vs 83.2%, P=.05), and the proportion of 5-9 cell embryos of normal embryos (2.7 vs 21.4%, P<.05) Of 10 gilts allowed to go to term, 1 farrowed two pigs and 4 are at 73 to 94 days of gestation. These results demonstrate the reduced developmental potential of embryos produced from sorted and frozen boar sperm, but that pregnancies can be established.

Key Words: Flow cytometric sorting, Boar spermatozoa, Sperm cryopreservation

838 Effects of transforming growth factor β (TGF) on development of bovine embryos *in vitro*. A.L. King*, D.L. Funk, R.D. Smith, D.B. Imwalle, L.A. Anderson, and K.K. Schillo, *University of Kentucky, Lexington, KY.*

The objective of this experiment was to determine the dose-response relationship between TGF and development of bovine embryos following collection from donor cows. Estrous cycles of six Angus cows were synchronized, and animals were treated with FSH to induce superovulation. Cows were inseminated artificially and embryos were collected nonsurgically six days after breeding. A total of 52 viable embryos were collected (8.6 ± 2.9 embryos per cow). Embryos were sorted by grade and quality and then cultured in 2 ml of a commercial holding medium containing TGF at concentrations of 0 (n=12), .03 (n=8), .3 (n=12), 3.0 (n=8), and 30 ng/ml (n=12) for 96 h. Media was changed and embryos re-evaluated every 12 h. There was a significant ($P < .01$) linear relationship ($R^2 = .964$) between the log of the dose of TGF and percentage of embryos reaching the expanded blastocyst stage. Ratio of embryos reaching this stage in the 0 ng/ml dose (5/12), was not different from those of the .03 (4/8), .3 (7/12), or 3 (5/8) ng/ml doses, but was different ($P < .05$) from that of the 30 ng dose (9/12). These results are consistent with the hypothesis that TGF may enhance development of bovine embryos. Whether or not this peptide can improve efficacy of embryo transfer in cattle remains to be determined.

Key Words: TGF, Embryo Transfer, Bovine

839 The effects of phytohemagglutinin and pokeweed mitogen on bovine oocyte maturation *in vitro*. S. Wang¹, K.E. Panter*², J.N. Stellflug³, R.C. Evans¹, and T.D. Bunch, ¹ADVS Department, Utah State University, Logan, ²USDA-ARS, Poisonous Research Laboratory, Logan, UT, ³USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

Phytohemagglutinin (PHA) and pokeweed mitogen (PWM), the extracts from *Phaseolus vulgaris* and *Phytolacca americana*, respectively, are two mitogenic agents causing blastoid reaction to produce a short-lived burst of mitosis involving small lymphocytes. This study investigated the effects of PHA and PWM on bovine oocyte maturation as indicated by the subsequent preimplantation embryo development *in vitro* using a randomized complete block (5 replications) design with three treatments (TRT). Bovine oocytes (n = 736) were aspirated from abattoir ovaries and *in vitro* matured (IVM) in the media containing PWM (Gibco, Cat. No. 15360-019) 10 μ l/ml (TRT1), PHA (Gibco, Cat. No. 10576-015) 10 μ l/ml (TRT2) or none of them (Control), respectively. The IVM culture lasted for 24 h in a humidified 5% CO₂ atmosphere at 39 °C. The IVM oocytes were fertilized *in vitro* (IVF) and the IVM/IVF derived zygotes were then *in vitro* cultured (IVC) in modified CR2 medium. Embryo development was evaluated at d 2, d 6, and d 8 (IVF = d 0). Percentage data were angularly transformed and analyzed by ANOVA. The cleavage rates were 83.5%, 90.0% and 88.9%. The percentage of morulae at d 6 was 26.6, 53.9 and 54.4; and the percentage of blastocysts at d 8 was 1.4, 12.7 and 12.9 for TRT1, 2 and 3, respectively. The cleavage rate and the numbers of embryos developed to morulae and blastocyst stages in PWM medium were significantly lower than those in PHA and Control ($P < 0.05$), indicating that PWM adversely influenced bovine oocyte maturation and the effects are extended to subsequent embryo development. However, there was no difference ($P > 0.05$) between PHA and Control. In conclusion, bovine oocyte *in vitro* maturation may be adversely affected by mitogenic agents, depending on their sources, as shown by the subsequent development of preimplantation embryos *in vitro*.

Key Words: *In vitro* maturation, Phytohemagglutinin, Pokeweed mitogen

840 *In vitro* maturation medium supplemented with bovine follicular fluids on subsequent embryo development. S. Wang*¹, Y. Liu¹, K.E. Panter², J.N. Stellflug³, R.C. Evans¹, and T.D. Bunch¹, ¹ADVS Department, Utah State University, Logan, ²USDA-ARS, Poisonous Research Laboratory, Logan, UT, ³USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

This study investigated the effects of bovine follicular fluids (bFF) collected from various sizes of follicles on bovine embryo development *in vitro* using a randomized complete block (8 replications) design with five *in vitro* maturation (IVM) treatments (TRT). Follicular fluids were

aspirated from follicles of abattoir ovaries. Oocytes (n = 3904) were aspirated from 5 to 7 mm follicles, washed in hepes-TALP five times and moved into IVM medium supplemented with 20% (v/v) bFF from follicles < 2 mm (TRT1), 3-7mm (TRT2), 8-15 mm (TRT3), and >15 mm (TRT4) in diameter. The IVM medium without bFF served as control (TRT5). The IVM culture lasted for 24 h in a humidified 5% CO₂ atmosphere at 39 °C. The IVM cultured oocytes were then subjected to *in vitro* fertilization (IVF) and *in vitro* culture (IVC). Cleavage rates were determined at 45 h after IVF. Embryo development was evaluated at d 6 and d 8 (IVF = d 0). Percentage data were angularly transformed and analyzed by the ANOVA. The cleavage rates were 82.1%, 81.9%, 83.5%, 81.4% and 82.8%; the percentage of morulae at d 6 was 41.2, 41.6, 41.1, 48.9 and 49.5; and the percentage of blastocysts at d 8 was 25.4, 25.0, 26.7, 29.3 and 29.6, for TRT1, TRT2, TRT3, TRT4 and control, respectively. There was no significant ($P > 0.05$) difference with respect to oocyte cleavage. However, there were significantly ($P < 0.05$) fewer embryos that developed to morula and blastocyst stages after matured in the medium supplemented with bFF from small follicles (<2mm and 3-8 mm) than those supplemented with bFF from large follicles (>15 mm), indicating that bFF from small size follicles (<15 mm) adversely influence *in vitro* development of bovine oocytes to the morulae and blastocyst stages. There was no significant difference in embryo development between TRT4 and control. These results suggest that bovine embryo development was affected by the bFF from various size of the follicles supplemented to IVM medium.

Key Words: Bovine, Follicular fluid, *In vitro* maturation

841 Embryonic development in beef cattle administered ergotamine tartrate to simulate fescue toxicosis. M. E. Hockett*, T. M. Towns, J. L. Edwards, N. R. Rohrbach, and F. N. Schrick, *University of Tennessee, Knoxville.*

A replicated experiment was performed to determine the effects of simulated fescue toxicosis on early embryonic development in beef cattle. Beef cows and heifers were randomly allotted by age, breed and body condition to be fed a 2:1 ground corn/soybean meal mix supplemented with either 0 (CON, n=38) or 40 μ g/kg BW ergotamine tartrate (TRT, n=37). Following a 30-d adjustment period on respective diets, animals were artificially inseminated at estrus with semen of known fertility. Weekly BW, body temperatures and blood samples were collected throughout the study. Six days following mating, blood was collected and ovaries were scanned with ultrasonography to determine volume and location of the corpus luteum. Single embryos were flushed from the uterine horn ipsilateral to the corpus luteum and scored for quality (scale of 1, excellent to 4, degenerate) and development (scale of 1, unfertilized to 9, expanded hatched blastocyst). Prolactin concentrations were decreased by d 20 of feeding ergotamine tartrate in TRT (83.4 ± 15.7 ng/mL) compared to CON animals (127.8 ± 15.7 ng/mL; $P < .05$). Concentrations of progesterone at embryo recovery ($2.9 \pm .2$ ng/mL) did not differ. Embryo recovery tended to be greater ($P = .08$) for CON (68.4%) than for TRT (48.7%); but flush scores (range of 1, excellent to 3, poor) did not differ. Embryo development to stage 4 (compact morula) or higher was greater for embryos collected from CON (88% or 22/25) compared to TRT animals (56% or 10/18; Fisher's Exact Test, $P = .02$). The percentage of transferrable embryos (quality score 1,2 or 3 on the 1-4 scale) tended to be higher ($P = .09$) for CON (88% or 22/25) than for TRT (61% or 11/18). Degenerate embryos were recovered more frequently from TRT (39% or 7/18) than CON animals (12% or 3/25). These results demonstrate that ergotamine tartrate administration decreased embryo quality and development prior to day 6 after mating. Fescue toxicosis may negatively impact reproduction through alterations in early embryo development.

Key Words: Beef cattle, Fescue toxicosis, Embryo

842 Interaction of endophyte-infected fescue and heat stress on ovarian function in the beef heifer. J. M. Burke*¹, F. N. Kojima², B. E. Salfen², S. L. Wood², D. J. Patterson², M. F. Smith², M. C. Lucy², W. G. Jackson¹, and E. L. Piper³, ¹USDA, ARS, Booneville, AR, ²University of Missouri, Columbia, ³University of Arkansas, Fayetteville.

Objective was to examine interaction of fescue and heat stress (HS) on ovary development. Heifers were fed endophyte-free (E-) or endophyte-infected seed (E+; 18.4%) at thermoneutral (S-) or HS (S+; E-S-, E-S+, E+S-, E+S+; n = 6/treatment) 4 wk before and 3 wk after synchronized

ovulation (7-11 Synch; D 0 was d of expected ovulation). Serum was collected and ovaries were monitored every other d after PGF until D 20 or ovulation. Size of follicles > 4 mm and CL were recorded. Heifers were subjected to 19°C, 50% RH from D -8 to -2 and S+ heifers to 31°C/25°C from D -1 until D 20. Feed intake was not different between E- and E+ heifers, but was reduced in S+ vs S- heifers (HS x d, P < .01). Water intake was not different among treatments. There was an interaction between diet, HS, and d for AM (P < .001) and PM (P < .001) rectal temperature and a diet x d (P < .001, AM; P < .01, PM) and HS x d (P < .001, AM; P < .001, PM) interaction for respiration rate. Serum P4 was reduced in S+ heifers and to a greater extent in E+S+ heifers (HS x d, P < .06; $y_{E-S-} = -3.6 - 2.3x - .21x^2 - .0049x^3$, $y_{E-S+} = -1.7 - 1.3x^2 - .0023x^3$, $y_{E+S-} = -1.7 - 1.8x - .17x^2 - .0043x^3$, $y_{E+S+} = -.66 - .72x - .061x^2 - .0013x^3$, where y = P4 and x = d; P < .003). Diameter of the CL was reduced in S+ heifers ($y_{S-} = 13.5 - 1.5x - .067x^2$, $y_{S+} = 14.8 - .77x - .034x^2$, where y = CL diameter and x = d; P < .07). Serum E2 was reduced in E+ heifers ($y_{E-S-} = 6.6 + .67x + .026x^2$, $y_{E-S+} = 2.6 - .0035x - .0024x^2$, $y_{E+S-} = 5.9 + .72x + .029x^2$, $y_{E+S+} = 4.6 + .49x + .019x^2$, where y = E2 and x = d; P < .001). Similarly, diameter of ovulatory dominant follicle was reduced in E+ heifers (diet x d; P < .07). Intake of E+ reduced P4 only during HS, but reduced E2 under S- and S+ conditions. Impaired follicle function may explain reduced pregnancy rates commonly observed in heifers grazing E+ pasture.

Key Words: Beef, Fescue, Ovary

843 Enhancement of superovulatory response using a norgestomet implant during the FSH treatment period. G. W. Bednar* and J. R. Pursley, *Michigan State University, East Lansing, MI*.

Results from studies predicting or controlling the onset of a new follicular wave for superovulation are inconsistent. The objectives of this experiment were: 1) to determine if a norgestomet implant inserted during the FSH injection period would allow more follicles to reach the ovulatory pool when FSH was initiated during follicular dominance, and 2) to determine the fate of the 1st wave DF and its effect on ovulation rates. Beef cows were synchronized with two injections of PGF2 α 14 days apart. Cows detected in estrus (n = 28) were assigned to three groups; GROUP 1 cows began FSH on d of emergence of the 2nd follicular wave (ranged from d 7 to 9 of the estrous cycle) and served as the control. GROUP 2 and 3 cows began FSH during follicular dominance (d 5 or 6 of estrous cycle). In addition, Group 2 cows received a norgestomet implant during the FSH treatment period. All cows received a total of 380 mg Folltropin-V[®] during a 4.5 d period in decreasing 2x/d doses. Cows received 25 mg PGF2 α on d 3.5 and 4. Follicles and CL were mapped daily using ultrasonography. All cows (19/19) in GROUP 2 and 3 responded to FSH with emergence of a new follicular wave. Numbers of new follicles 2 d after initiation of FSH were not different (P > 0.05) between treatments, 39 \pm 6.0, 37 \pm 4.9, 35 \pm 5.2, for GROUPS 1, 2, and 3, respectively. Number of follicles ovulating following FSH treatment in cows with > 1 ovulation was greater (P < 0.05) in GROUP 1 (25.9 \pm 2.9) and GROUP 2 (29.9 \pm 3.2) compared to GROUP 3 (16.4 \pm 5.0). Of the cows that did not respond with multiple ovulations, the 1st wave DF ovulated either during (4 of 4 cows in GROUP 2) or after (2 of 2 in GROUP 3) the FSH treatment period. In cows with multiple ovulations, the 1st wave DF ovulated in 6/8 cows in GROUP 2 and 0/5 cows in GROUP 3. In summary, the fate of the 1st wave DF appeared to play a key role in determining whether follicles were allowed to ovulate. Also, it appears the norgestomet implant allowed sufficient additional time for superstimulated follicles to reach the ovulatory pool when the DF remained functional and ovulated following FSH.

Key Words: Dominant follicle, FSH, Norgestomet

844 Follicular dynamics and oocyte quality during early lactation in Holstein cattle. A.H. Walters*, T.L. Bailey, J. Strauss, and F.C. Gwazdauskas, *Virginia Polytechnic Institute & State University, Blacksburg, VA*.

Ultrasound-guided transvaginal follicular aspiration was used to obtain oocytes from cows to study follicular development and oocyte morphology. Follicular aspiration was conducted once during wk 1 to 12 postpartum on 102 lactating cows with 6 groups, separated by biweekly

intervals. Approximately one half of the aspirated cows at each session were from the early groups (wk 1-2, 3-4, or 5-6) and the other half from the later groups (wk 7-8, 9-10, or 11-12). On the day of aspiration the number of follicles on each ovary and their sizes, small (2-5 mm), medium (6-10 mm) and large (\geq 11 mm), were recorded. The collected oocytes were morphologically classified into 4 grades, with A = excellent, B = good, C = fair, and D = poor. A Chi square analysis revealed a significant (P < .01) difference in the distribution of small follicles over time between first lactation and older cows (\geq 2nd lactation). The percentage of small follicles increased with week postpartum in first lactation cattle (3 % at wk 1-2 to 57% at wk 11-12), while older cows peaked at 58% in wk 7-8, and then decreased to 34% at 11-12 wk. Medium and large follicles followed similar patterns. When compared across time postpartum, the distribution of A and B quality oocytes was cyclical, peaking in wk 7-8 and wk 11-12. This was different from the distribution of D quality oocytes (P < .01) which peaked at 70% in wk 1-2, decreased to 27% in wk 7-8, and then increased to 55% in wk 11-12. The distribution of oocyte quality also differed across parity, where the percentage of A quality oocytes was higher (12% vs 9%) for older cows compared to first lactation cattle (P < .05). Additionally, first lactation cattle had a higher percentage of B quality oocytes than older cows (18% vs 14%; P < .05). The changes in follicular dynamic patterns and oocyte quality in younger and mature cattle may be an indication of the impact of early lactational performance and growth demands on subsequent fertility.

Key Words: Follicle, Oocyte, Lactation

845 Effects of follicle stimulating hormone (FSH) treatment on follicular development and oocyte retrieval in seasonally anestrous ewes. T.K. Stenbak*, L.P. Reynolds, D.A. Redmer, and A.T. Grazul-Bilska, *Department of Animal and Range Sciences, North Dakota State University, Fargo, ND, USA*.

To determine the effects of FSH and Syncro-Mate-B (SMB) treatment of seasonally anestrous ewes on the number of follicles, and the recovery and quality of oocytes, a 2 x 3 factorial study was designed. Half of the ewes were implanted with SMB for 14 days and the other half of the ewes were not implanted. SMB-implanted and non-implanted ewes were then assigned to one of three treatments: no treatment (control, n = 12), FSH-injected for two days (2d, n = 21) or FSH-injected for 3 days (3d, n = 15). Ewes received twice daily (morning and evening) intramuscular injections of FSH, beginning on day 12 (3d) or day 13 (2d) after SMB implantation. Ewes were laparotomized 15 h after the last FSH-injection to determine number of small (<3 mm) and large (>3 mm) follicles and to retrieve oocytes. Oocytes were evaluated as atretic or healthy on the basis of morphology. Ewes treated with SMB had similar (P > 0.05) numbers of follicles, numbers of oocytes, and numbers of healthy oocytes compared with ewes that did not receive SMB; therefore, data were combined across SMB implanted and non-implanted ewes. FSH-treatment increased (P < 0.05) the number of large (1.5 \pm 0.3 vs 13.0 \pm 1.3 for control and FSH-treated ewes, respectively) and the total number (6.9 \pm 0.9 vs 18 \pm 1.5) of follicles, and the number of oocytes recovered from large follicles (1.3 \pm 0.3 vs. 11 \pm 1.4) and total follicles (5.6 \pm 1.0 vs. 15.3 \pm 1.3). There was no difference between the control and the FSH-treated ewes in the number of oocytes recovered from small follicles (4.3 \pm 0.9 and 3.7 \pm 0.7). The recovery rate of oocytes (number of oocytes recovered divided by the number of follicles; 79.5% \pm 9.0 and 83% \pm 2.4) and the percent of oocytes that were healthy (84% \pm 5.0 and 84% \pm 2.4) did not differ between the control and the FSH-treated ewes. However, the number of healthy oocytes was greater (P < 0.05) for the FSH-treated ewes than the control ewes (11.8 \pm 1.8 vs. 4.6 \pm 0.8). These data indicate that SMB has no effect on follicular development, but that FSH-treatment improves follicular development and the number of healthy oocytes retrieved from seasonally anestrous ewes. Supported by NDSU RDSP1172 grant.

Key Words: Ewes, Follicle Stimulating Hormone (FSH), Oocyte collection

846 Effect of FSH on in vitro growth of early antral follicles from bovine fetal ovaries. K. R. Chohan and A. G. Hunter*, *Dept. of Animal Science, University of Minnesota, Saint Paul, USA*.

Effect of FSH was evaluated on in vitro growth of bovine early antral follicles. Ovaries of 7 to 9 month old fetuses were dissected and antral

follicles between 500 μm to 1.3 mm were selected. Follicles similar in diameter were divided into two equal groups in each replicate. The culture medium was Minimal Essential Medium supplemented with 1% ITS (Insulin 6.25 μg , Transferrin 6.25 μg , Selenium 6.25 μg), 3 mg/ml BSA (F-V), 2 mM glutamine, 2 mM hypoxanthine, 0.23 mM sodium pyruvate, 100 $\mu\text{g}/\text{ml}$ streptomycin, 100 IU/ml penicillin, 25 $\mu\text{g}/\text{ml}$ of fungizone, 1 $\mu\text{g}/\text{ml}$ estradiol, 10% FCS and 15 mM HEPES. Follicles were cultured individually in 96 U-shaped well plate for 15 days in 70 μl of medium with 100 ng/ml FSH (n=102) or without FSH (n=92) under 20 μl of mineral oil at 39°C and 5% CO₂. Follicles were transferred to new wells with pre-equilibrated medium after every 24 hrs and follicle diameters were recorded at 48 hrs intervals. Data were analyzed using repeated measures analysis in PROC MIXED procedure of SAS system. No effect of FSH was observed on development in follicle size (P>0.05). The follicles appeared morphologically healthy at 15 days culture as no signs of atresia were observed. However, follicle diameter decreased significantly (P<0.05) with time in both groups. These results indicated that refinements in culture conditions are needed for full follicle development.

Group	D 1	D 3	D 5	D 7	D 9	D 11	D 13	D 15
	866.7	877.3	847.3	828.6	814.9	798.7	791.3	749.6
	±	±	±	±	±	±	±	±
FSH	20.2	20.2	20.3	20.3	20.3	20.2	20.2	20.1
	892.8	893.2	855.2	840.5	820.5	806.2	778.5	745.4
	±	±	±	±	±	±	±	±
CONT	21.3	21.3	31.3	21.3	21.3	21.3	21.3	21.3

Follicle diameters shown in table are in μm and Mean \pm SE.

Key Words: Bovine, Follicle, Culture

847 Effect of culture duration on germinal vesicle and meiotic development of bovine fetal oocytes isolated from small antral follicles. K. R. Chohan and A. G. Hunter*, Dept. of Animal Science, University of Minnesota, Saint Paul, USA.

The effect of duration of culture was observed on germinal vesicle and meiotic development of oocytes from < 2 mm follicles from ovaries of 7.5 months to term bovine fetuses. Oocytes were evaluated at isolation (0 hrs) and after 24 and 48 hrs of *in vitro* culture. The culture medium was M199 supplemented with 10 $\mu\text{g}/\text{ml}$ FSH, 10 $\mu\text{g}/\text{ml}$ LH, 1.5 $\mu\text{g}/\text{ml}$ estradiol, 75 $\mu\text{g}/\text{ml}$ streptomycin, 100 IU/ml penicillin, 10mM hepes and 10% FCS. Cumulus cells were removed using 3 mg/ml hyaluronidase and repeated pipetting. Denuded oocytes were fixed in 3% glutaraldehyde, stained with DAPI and evaluated for stage of germinal vesicle (GV) and subsequent meiotic development. Data were analyzed using Chi Square. The majority of oocytes were at GV-I (36.4%) and II (49.7%) at isolation (0hrs). A shift was observed (P<0.05) from the early to final stages of GV and meiotic development after 24 hrs of culture as 22.8% oocytes were observed at GV-V, 14.9% at pre-metaphase and 17.5% at metaphase-I. Only 7.9% of the oocytes were able to reach the metaphase-II stage. A significant difference (P<0.05) was observed in GV morphology and meiotic development after 48 hrs of culture compared to results at 0 hrs as more oocytes (18.3%) reached metaphase-II. The degeneration rates increased from zero percent at isolation (0hrs) to 4.4% and 13.5% after 24 and 48 hrs of culture (P<0.05), respectively. Although the fetal oocytes from < 2 mm follicles showed improvement in germinal vesicle development and meiotic competence with an increase in culture duration, these results are still too poor to be considered for *in vitro* fertilization procedures. Therefore, it will be necessary to determine if fetal oocytes from < 2 mm follicles, need a modified medium to achieve *in vitro* developmental competence.

Oocytes (#)	GV-I (%)	GV-II (%)	GV-III (%)	GV-IV (%)	GV-V (%)	GV-BD (%)	Pre-met (%)	Met-I (%)	Met-II (%)	Degn (%)
0 H	36.4 ^a	49.7 ^a	5.6 ^a	3.5 ^a	4.9 ^a	0.0 ^a	0.0 ^a	0.0 ^a	0.0 ^a	0.0 ^a
24 H	0.0 ^b	7.0 ^b	9.6 ^a	7.9 ^a	22.8 ^b	7.9 ^b	14.9 ^b	17.5 ^b	7.9 ^b	4.4 ^b
48 H	0.0 ^b	1.9 ^b	3.8 ^a	2.9 ^a	15.4 ^b	6.7 ^b	18.3 ^b	19.2 ^b	18.3 ^c	13.5 ^c

Key Words: Fetal, Oocyte, Development

848 Temporal and spatial expression of tissue inhibitor of matrix metalloproteinase 1 (TIMP-1) in bovine corpus luteum. B. Zhang* and P.C.W. Tsang, Department of Animal & Nutritional Sciences, University of New Hampshire, Durham NH 03824.

The corpus luteum (CL) is a dynamic endocrine gland that undergoes dramatic structural and functional changes that are associated with various phases of its life span. The matrix metalloproteinases (MMPs) and TIMPs, which we have shown to be present in CL obtained over the estrous cycle, may mediate these changes. In order to gain a greater understanding of the role of TIMPs in luteal function, we explored the temporal and spatial expression of TIMP-1 in bovine CL. Luteal tissues were collected from early (4 days old, estrus= day 0), mid (10-11 days old) and late (16 days old) phases (n=3 for each phase) of the estrous cycle. Proteins were extracted from all samples, and analyzed by Western blotting and reverse zymography. In addition, frozen tissue sections were also prepared for *in situ* hybridization and immunocytochemistry. Reverse zymography indicated that TIMP-1 was the major TIMP present in bovine CL. Western blotting showed no differences in TIMP-1 protein levels between early and mid phases. However, TIMP-1 levels decreased (p<0.05) from mid to late stage CL. *In situ* hybridization and immunocytochemistry revealed that TIMP-1 mRNA and protein had a similar cellular distribution. Large luteal cells from all three ages of CL expressed TIMP-1, with the highest level of expression detected in tissue of the mid cycle phase. Furthermore, TIMP-1 was also localized in capillary smooth muscle cells, but expression levels were greater in late than early CL. Overall, these results indicated that the variations in TIMP-1 expression may suggest diverse roles for this multifunctional protein in the physiology of CL during the estrous cycle. (Supported by Hatch 343 to PCWT)

Key Words: corpus luteum, TIMP-1, bovine

849 Immunization of sheep against homologous placental lactogen: effects on lamb birth weight, milk production and conception rate. H. Leibovich*, A. Gertler¹, F.W. Bazer², and E. Gootwine, ¹The Hebrew University of Jerusalem, Israel, ²Texas A&M University System Health Science Center, ³Institute of Animal Sciences, ARO, The Volcani Center, Israel.

The effect of active immunization of sheep against recombinant ovine placental lactogen (oPL) on reproduction and production performances was examined. Five month old Booroola-Assaf (n=16) and Assaf (n=35) ewe lambs were immunized against oPL. Anti oPL antibody titers, maternal serum levels of oPL, reproductive performances and lamb birthweight were followed up to the second lambing in the immunized ewes and in control non-immunized ewes (n=129). All the immunized ewes developed anti oPL antibodies which could interfere with oPL bioactivity in *in-vitro* cell proliferation assays. Conception rate did not differ (P>0.05) between immunized and non immunized ewes. Presence of abundant antibody-bound non-active oPL in the sera of immunized ewes, as was shown by Western analysis indicates enhanced oPL production by the placenta during pregnancy following the immunization. Birthweight of lambs born to the immunized ewes was higher (P<0.01) than birthweight of lambs born to control ewes on the average by 0.2, 0.5 and 0.9 kg for singles, twins and triplets, respectively. Immunized ewes produced in the first 3.5 months of the lactation 17% and 25% more milk than control ewes (P<0.02) in the first and the second lactations, respectively. These findings suggest that oPL may not play a major role in maternal recognition of pregnancy but plays an important role in fetal growth and mammogenesis. Immunization against oPL may have a potential application in manipulating fetal growth in prolific sheep and milk production of both dairy and mutton ewes.

Key Words: Placental Lactogen, Milk production, Lamb birth weight

850 Lambing rates after oxytocin-induced cervical dilation, cervical manipulation, and laparoscopic artificial insemination. J. Stellflug*, M. Wulster-Radcliffe², E. Hensley², and G. Lewis¹, ¹USDA-ARS US Sheep Experiment Station, Dubois ID, ²Virginia Tech University, Blacksburg.

Exogenous oxytocin (OT) dilates the cervix and facilitates transcervical, intrauterine AI in sheep. Even though OT and cervical manipulation (CM) have not affected ovum fertilization rates, their effects on lambing rates have not been adequately evaluated. Thus, to further evaluate OT

and CM, multiparous white-faced ewes (n = 220) were assigned to a 2 x 2 factorial array of treatments: 1) saline-sham CM, 2) saline-CM, 3) OT-sham CM, and 4) OT-CM. Progestogenated pessaries were used to synchronize estrus, and 400 IU of eCG were injected i.m. at pessary removal. Between 48 and 54 h later, 200 USP units of OT or 10 mL of saline were injected i.v., approximately 25 min before sham CM or CM. Immediately after sham CM or CM, laparoscopy was used to AI all ewes with frozen thawed-semen composited from several rams (50 x 10⁶ to 75 x 10⁶ spermatozoa/200 µL diluent). At 10 to 12 d after AI, ewes were mated with black-faced rams for 21 d. Jugular blood samples were collected between 24 and 26 d after AI for pregnancy-specific protein B (PSPB) RIA. A PSPB-positive sample indicated that a ewe was, or had been, pregnant from AI. Time of lambing and type of lamb were recorded. Chi-square procedures were used. The PSPB pregnancy rate and lambing rate were both 62% in saline-sham controls. The CM did not affect either pregnancy (69%) or lambing rate (64%). The OT decreased (P < 0.05) PSPB pregnancy rate (59%), lambing rate (56%) in OT-sham ewes, and pregnancy and lambing rate in CM ewes (both 43%). In ewes not pregnant from AI, neither CM nor OT affected lambing rates to the next estrus, indicating that there was no long-term damage to the cervix or uterus. In summary, CM did not affect fertility after laparoscopic AI, but OT caused decreases in lambing rate independent of CM. Reduced doses of OT are being tested, but, in the event OT will not be usable for AI, it may still be a valuable tool for training AI personnel.

Key Words: Sheep, Artificial Insemination, Cervix

851 Progesterone down regulates the uterine immune response to infectious bacteria in gilts. M. C. Wulster-Radcliffe*¹, R. C. Seals¹, and G. S. Lewis², ¹Virginia Polytechnic Institute and State University, Blacksburg, VA, ²USDA Sheep Experiment Station, Dubois, ID.

A progestogenated uterus is susceptible to infections, but this is not well characterized in gilts. Therefore, the effects of day of the estrous cycle (DOC) and progesterone (P₄) were evaluated. Gilts (n = 5/group) were assigned to treatments in 2x2 factorial arrays. In Exp. 1, DOC and bacterial challenge (BC) were main effects. On d 0 or 8, uteri were inoculated with either 70x10⁷ cfu of *Escherichia coli* and 150x10⁷ cfu of *Arcanobacterium pyogenes* in PBS (10 mL) or PBS. In Exp. 2, ovariectomy (OVEX) and P₄ supplementation were main effects. On d 0, gilts were OVEX or a sham procedure was performed. After surgery, gilts received i.m. injections of P₄ (10 mg/5 mL) or 5 mL of safflower oil diluent twice daily. On d 8, gilts were inoculated with the same doses of bacteria as in Exp. 1. In Exp. 1 and 2, vena caval blood was collected for 4 d, gilts were killed, and uteri were collected. Sediment (packed-cell volume; PCV) and ability to culture *E. coli* and *A. pyogenes* from uterine flushings were used to diagnose infections. Differential white blood cell counts and lymphocyte blastogenic response to mitogens (i.e., concanavalin A [Con A] and lipopolysaccharides [LPS]) were used to evaluate immune function. In Exp. 1, d-8 gilts receiving bacteria developed infections (PCV > 5%), but d-0 gilts receiving bacteria did not (PCV < 1%). Daily percentages of neutrophils and lymphocytes changed (P < .05) in response to DOC and BC. Basal and Con A-stimulated blastogenesis were greater (P < .05) for d-0 than for d-8 gilts. In Exp. 2, gilts exposed to P₄ (i.e., ovarian or injected) had infections (PCV > 5%). Daily percentages of neutrophils and lymphocytes changed (P < .01) in response to OVEX, and neutrophils changed (P < .05) in response to P₄. The Con A- and LPS-stimulated blastogenesis increased in response to OVEX (P < .05) and decreased in response to P₄ (P < .05). Day of the estrous cycle and P₄ supplementation changed the uterine immune response to infectious bacteria in gilts.

Key Words: Gilt, Progesterone, Uterine infections

852 Prostaglandin modulation of the uterine responses to infections in ewes. R. C. Seals*, M. C. Wulster-Radcliffe, and G. S. Lewis, Virginia Polytechnic Institute and State University, Blacksburg.

Luteal-phase uteri are susceptible to infections, and exogenous progesterone (P₄) can down-regulate, whereas PGF_{2α} can up-regulate, uterine immune functions. Thus, we evaluated these factors. In Exp. 1, ewes (n = 6/group) were assigned to treatments in a 2 x 2 factorial; stage of estrous cycle and bacterial challenge were main effects. On d 0 or 6, uteri were inoculated with either 35 x 10⁷ cfu of *Escherichia coli* and

75 x 10⁷ cfu of *Arcanobacterium pyogenes* in 5 mL of PBS or PBS. Vena caval blood was collected for 3 d, ewes were killed, and uteri were collected. Lymphocytes were assigned to treatments in a 2 x 2 factorial; 10⁻⁷ M PGF_{2α} and 10⁻⁷ M indomethacin (INDO), a PG-synthesis inhibitor, were main effects. Amount of sediment and ability to culture *E. coli* and *A. pyogenes* from uterine flushings were used to diagnose infections. Lymphocyte blastogenesis (³Hthymidine incorporation) was used to evaluate immune function, P₄ was quantified, and white blood cells (WBC) were counted. The P₄ was greater (P < .01) for d 6 than for d 0 (6.6 vs 1.3 ng/mL). Neutrophil numbers were greater (P < .01, 53 vs 44/100 WBC, SEM = .4), but lymphocytes were less (P = .04, 21 vs 34/100 WBC, SEM = .5), after bacteria than after PBS. Bacteria on d 6, but not on d 0, induced infections. Blastogenesis was greater for d 0 than for d 6 in response to concanavalin A (Con A) alone (P < .05, 4.1 vs 3.1 pmol, SEM = .5) and to Con A + PGF_{2α} (P < .01, 3.5 vs 2.7 pmol, SEM = .4), but INDO did not affect blastogenesis. In Exp. 2, uteri (n = 6 ewes/group) were inoculated with bacteria on d 6. Ewes were treated with 15 mg of Lutalyse or PBS on d 9, killed on d 11, and uteri were collected. Protocols were the same as in Exp. 1. The PGF_{2α} reduced (P < .01) P₄ (1.5 vs 11.7 ng/mL, SEM = .8), tended (P = .06) to increase neutrophils (48, 54, and 42/100 WBC, SEM = 4, on d 9, 10, and 11, respectively), allowed ewes to clear infections, but did not affect blastogenesis. Stage of the estrous cycle of ewes seems to have a greater effect on uterine immune function than PGF_{2α}.

Key Words: Sheep, Uterine Infections, Prostaglandin F2alpha

853 Effects of selection for ovulation rate or uterine capacity on gravid uterine, farrowing, and weaning traits in swine. R. K. Christenson*¹ and K. A. Leymaster¹, ¹USDA, Agricultural Research Service, U.S. Meat Animal Research Center, Clay Center, NE.

Eleven generations of selection for ovulation rate (OR) or uterine capacity (UC) increased (P < 0.01) OR (3.2 ova) or UC (1.1 pigs per uterine horn) in swine [Leymaster & Christenson, J. Anim. Sci. 78(Suppl. 1), 2000]. Our objective was to explore the effects of enhanced OR or UC on gravid uterine, farrowing, and weaning traits. Littermate control- (CO), OR-, or UC-line gilts were randomly assigned either to be unilaterally hysterectomized-ovariectomized, mated within line, and slaughtered at 105 days of gestation or to remain intact, mated within line, and farrowed. At slaughter, CO line (n = 80) means for gravid uterine horn, total fetal, total placental, and empty uterine weight were 10.6 ± 0.4, 5.4 ± 0.2, 1.31 ± 0.05, and 1.87 ± 0.05 kg, respectively. Gilts selected for OR (n = 78) or UC (n = 62) deviated from the CO gilts by -0.9 and 1.5**, -0.5 and 0.8**, -0.21** and 0.16**, and 0.04 and 0.15* kg, respectively (*P < 0.05, **P < 0.01). UC exceeded CO line gilts by 8 to 15% for these reproductive traits. At farrowing, CO line (n = 84) means for total number of pigs born, litter birth weight, number of pigs weaned, and litter weaning weight were 10.6 ± 0.3 pigs, 13.6 ± 0.3 kg, 8.9 ± 0.3 pigs, and 40 ± 1.3 kg, respectively. Gilts selected for OR (n = 66) or UC (n = 62) deviated from the CO gilts by 0.7 and 0.9* pigs, -0.3 and 0.8* kg, 0.1 and 0.3 pigs, and 0 and 1 kg, respectively (*P < 0.05). OR and UC line gilts produced 7 and 9% more pigs at birth than CO line gilts. Simultaneous increases in both OR and UC are necessary to produce substantial increases in litter size at birth and subsequent farrowing and weaning traits.

Key Words: Swine, Selection responses, Reproductive traits

854 Estrus and ovarian responses to P.G.600 administered after Regumate withdrawal in gilts. M.J. Estienne*, A.F. Harper, C.E. Estienne, and J.W. Knight, Virginia Polytechnic Institute and State University, Blacksburg.

The effects of exogenous gonadotropins on the treatment-to-estrus interval and ovulation rate were assessed in gilts following termination of orally administered progestogen treatment. Randomly-cycling, cross-bred gilts (n = 64; 143.1 ± 9 kg BW; mean ± SE) were fed 2.7 kg of a complete ration containing 15 mg Regumate (Hoechst Roussel Vet, Warren, NJ) daily for 18 d. Twenty-four h after the last feeding of Regumate, 32 gilts received an i.m. injection of P.G.600 (400 I.U. PMSG and 200 I.U. HCG; Intervet Inc., Millsboro, DE) and 32 control gilts received an i.m. injection of deionized water. All gilts were checked for estrus twice daily (at approximately 0700 and 1900) in the presence of a mature boar, and were sacrificed 9 to 11 d after the onset of estrus. Ovaries were removed

and weighed, and corpora lutea (CL) were excised and weighed. Remaining ovarian tissue was minced and blotted and weight of follicular fluid determined. Follicles with a diameter of 12 mm or greater were considered cysts. The percentage of gilts displaying estrus and ovulating within 7 d after treatment and the treatment-to-estrus interval were similar ($P > .1$) for P.G. 600 treatment (93.8% and 4.1 ± 1 d, respectively) and controls (90.6% and 4.3 ± 1 d, respectively). Number of CL (indicative of ovulation rate) ($P < .01$) and mean CL weight ($P < .08$) differed between P.G. 600-treated gilts (28.8 ± 1.1 and $.48 \pm .01$ g, respectively) and controls (17.4 ± 1.1 and $.51 \pm .01$ g, respectively). Follicular fluid weight was greater ($P < .09$) for P.G. 600-treated gilts (4.4 ± 2 g) than for control gilts (3.8 ± 2 g). The percentage of gilts with follicular cysts and the number of cysts in these gilts were similar ($P > .1$) for P.G. 600 treatment (30% and $3.6 \pm .9$, respectively) and controls (17% and $1.4 \pm .2$, respectively). In summary, withdrawal of Regumate after 18 d of exposure resulted in a synchronous onset of estrus. Ovulation rate was enhanced by treating gilts with P.G.600 24 h after progestogen withdrawal.

Key Words: P.G. 600, Regumate, Gilts

855 Effectiveness of an early pregnancy test for cows. L. A. Pagels*, M. G. Daves, and C. S. Whisnant, *North Carolina State University, Raleigh.*

Early pregnancy tests are available for some species including humans. These depend upon the presence of a factor in pregnant animals that is not found in non-pregnant females. No such factor has been identified in cows. Recently, a kit has become commercially available (ECFTM, Concepto-Diagnostics, Knoxville, TN) that purports to be able to identify a factor secreted by the early bovine conceptus. The literature accompanying the kit states that the factor can be detected in blood or milk of pregnant cows from 48 hours to 20 days after breeding. The presence of two lines on the test indicates pregnancy while one line indicates an open cow. No independent verification of the accuracy of this kit has been reported. The purpose of this experiment was to test the accuracy of the kit using ultrasound between days 25-30 or palpation on days 35-42 for comparison. Blood samples were taken by tail vein puncture from 46 heifers or cows. All animals were between 9 and 15 days post-insemination. All tests were conducted according to the instructions provided by the manufacturer. All test reagents were stored refrigerated and allowed to come to room temperature before testing. Blood samples were allowed to clot and a single drop of serum was placed into the receptacle of the test cassette using the disposable pipettes provided. Then the wash solution was placed on the receptacle and the tests were allowed to sit for two hours at room temperature before being examined for the results. As per instructions the presence of a second line however faint was regarded as a sign of conception. Ultrasonography was performed on days 25-30 post-insemination or rectal palpation was performed between days 35-42. The test results corresponded with the results of the ultrasound examination or palpation 55% of the time. Of the 45% that disagreed, 21% were diagnosed pregnant by the test and were found to be open by palpation or ultrasonography. Twenty four % were diagnosed as open by the test and were later found to be pregnant. These data suggest that the current level of accuracy in the kit is insufficient.

Key Words: Pregnancy, Cows

856 Evaluation of an early conception factor test for use in dairy cattle. B. Gandy*¹, W. Tucker¹, P. Ryan¹, A. Williams¹, A. Tucker¹, A. Moore¹, R. Godfrey², and S. Willard¹, ¹Dept. of Animal and Dairy Sciences, Mississippi State Univ., ²Agric. Exp. Station, Univ. of Virgin Islands, St. Croix.

The ability to detect conception or conception failure post-breeding would be beneficial to producers in decreasing the number of days a cow remains open. To this end, the objective of this study was to evaluate a commercially available early conception factor (ECF) test for detecting the non-pregnant cow. Lactating Holstein cows ($n = 40$) were synchronized using an OvSynch protocol. Cows were inseminated using timed AI (day 0), and blood samples were collected daily through d 15 and on alternate days thereafter until d 30. Milk samples were also collected at varying intervals. Serum and milk ECF tests were conducted following the manufacturer's guidelines (Concepto Diagnostics, Knoxville, TN) on d 9, 15, 21 and 30. Ultrasonography was performed on d 30, palpation

on d 51 and serum samples analyzed for progesterone to confirm pregnancy. Pregnancy diagnosis revealed that 50% of cows were pregnant to AI, while serum and milk ECF analysis indicated a 100% and 37.5% pregnancy rate (d 30), respectively. Results of the serum and milk ECF tests disagreed with one another 36.9% of the time overall. Agreement between ECF and pregnancy diagnosis was 50.6% and 45.6% overall for serum and milk, respectively. The accuracy of a negative ECF result in identifying a non-pregnant cow varied greatly (0 to 100%) depending on the day of test. Regardless of accuracy by day, a negative ECF result could only identify 5% and 28.8% of non-pregnant cows overall for serum and milk ECF tests, respectively (i.e., true negatives). Moreover, the incidence of a false positive ECF result was 47.5% and 31.3% for serum and milk, respectively. Post-study re-testing of the d 9 serum samples (optimal test d) revealed that a negative ECF result was only 52.6% accurate in detecting the non-pregnant cow. Based upon these data, the current ECF test does not accurately identify the non-pregnant cow with the precision needed by the producer. [Supported in part by Concepto Diagnostics]

Key Words: Conception, Pregnancy, Cattle

857 The use of estrous synchronization, artificial insemination and a cow side early conception test on Holstein heifers in the tropics. R.W. Godfrey*¹ and S.T. Willard², ¹Agricultural Experiment Station, University of the Virgin Islands, St Croix, ²Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State.

The use of AI and estrous synchronization in the US Virgin Islands would be more acceptable to producers if producers could determine conception within a few days after AI due to limited availability of liquid nitrogen locally for long-term storage of frozen semen. This study was conducted to evaluate the use of an early conception test in conjunction with AI and estrous synchronization. Holstein ($n = 18$) heifers were treated with PG (Lutalyse[®], 25 mg, i.m., 11 d apart) to synchronize estrus. Heat detection was done with the use of Kmar patches. Heifers were inseminated using the am-pm rule. At 24 h after insemination a blood sample was collected, serum was harvested and used in an early conception test following the manufacturers instructions (ECFTM, Concepto Diagnostics, Knoxville, TN). Rectal palpation was done at 45 d after AI associated with a positive ECF test. Heifers that had a negative ECF test were treated with PG a 6 or 7 d later and bred by AI based on detection of estrus. This was repeated until there were no more heifers to breed. Accuracy of palpation and ECF tests were based on calving dates. Based on the final AI of each heifer, the ECF test yielded a true positive 38.9%, false positives 44.4%, a true negative 11.1% and a false negative 5.6% of the time. Over the course of this project there were 26 inseminations of 18 heifers and ECF tests 48 h after AI yielded true positive results in 26.9%, false positive results in 30.8%, true negative results in 38.5% and false negative results in 3.8% of the tests. Based on these results it does not appear that the ECF test (at 24 to 72 h post-AI) can be used to accurately differentiate between pregnant and open dairy heifers in the tropics. The low rate (true negative: 11.1 and 38.5%) of detecting open heifers would not be acceptable to the producer. [This study was supported in part by Concepto Diagnostics].

Key Words: Artificial Insemination, Cattle, Conception

858 Leptin secretion in heifers approaching puberty. C. S. Whisnant, H. Lowman, A. N. Elias, and L. A. Pagels, *North Carolina State University, Raleigh.*

Research in rodents suggests that leptin may be involved in regulating age at puberty. Underfed rats had delayed puberty but treatment with leptin reversed this effect. Little is known about leptin secretion in cattle. The objective of the current experiment was to examine changes in leptin secretion in heifers from weaning to puberty in two groups of heifers fed to gain at different rates. The diets contained adequate energy and protein for the rates of growth as determined by NRC. Two weeks after weaning twenty Angus or Simmental heifers ($n=10$ of each breed) were assigned by breed and body weight to be fed to gain either (high H) 0.91 kg/head/day or (moderate M) 0.45 kg/head/day. Initial weights were not different between groups (H 285.6 ± 19 kg vs. M 286.1 ± 24.6 kg). Calan gates were used to allow individual feeding. Animals were on dietary treatments for 84 days. Heifers were weighed every 14 days and blood samples were collected weekly for measurement of serum leptin and progesterone concentrations. Every 28 days five heifers from each group were cannulated and samples taken for 6 h at 15 min intervals. Serum leptin concentrations were determined in these samples as

well using the Linco Multi-Species kit. Data were analyzed using PROC GLM with treatment and breed in the model. Average daily gain was greater ($P < .01$) in H heifers (1.02 ± 0.17 kg) than M heifers ($0.65 \pm .04$ kg). No breed difference in serum leptin concentrations was detected. There was no difference between treatments in the number of heifers reaching puberty by the end of the study (10 in H group; 9 in M group) or age at which puberty occurred. Mean serum leptin concentrations were lower in M heifers (3.6 ± 0.3 ng/ml, $P < .01$) than in H heifers (6.4 ± 0.7 ng/ml) from 14 days after dietary treatment began until the end of the study. These data suggest that level of dietary energy can affect leptin secretion in heifers. At the rates of growth used in this study the difference in serum leptin concentrations was unrelated to age at puberty, which did not differ between treatments.

Key Words: Leptin, Puberty, Heifer

859 Plasma leptin concentrations in dairy cows: I) Effect of short-term fasting and refeeding. P.K. Chelikani^{*1}, J.D. Ambrose², D.R. Glimm¹, T.J. Kieffer¹, and J.J. Kennelly¹, ¹University of Alberta, Edmonton, Canada., ²Alberta Agriculture, Food & Rural Development, Edmonton, Canada..

In humans and rodents, leptin levels in circulation are reduced with fasting and rebound to prefasting levels on refeeding. We hypothesized that a similar physiological response occurs in dairy cows. Five Holstein dairy cows (BW 603 ± 30 kg; BCS 2.48 ± 0.05) were fasted for 48 h and subsequently refed. Blood samples were taken at 0 (baseline), 10, 22 and 46 h of fast, and at 4, 8, 12, 18 and 24 h after refeeding. Plasma leptin concentrations were determined using a multispecies double antibody assay kit (Linco Research, St. Louis, MO). Serial dilutions of a pooled bovine plasma sample were found to be parallel to the human leptin standard curve. Human leptin was quantitatively recovered from a bovine plasma sample. Assay sensitivity was 1 ng/ml. The intra- and interassay CV were 7.8% and 14.67% respectively. There was a significant decrease ($P = 0.03$) in plasma leptin concentrations at 10h fast (2.83 ± 0.23 ng/ml) compared to baseline (3.61 ± 0.23 ng/ml). However, there were no changes ($P > 0.05$) in leptin concentrations either at 22 and 46 h of fast, or during the refeeding period. Despite an initial decrease, the gradual rise in plasma concentrations of leptin with fasting is in contrast to the response observed in humans and rodents and warrants further study.

Key Words: Leptin, Fasting, Dairy cows

860 Concentrations of leptin in serum and milk from sows that differed in body condition at farrowing. M.J. Estienne^{*1}, A.F. Harper¹, C.R. Barb², and M.J. Azain³, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²USDA-ARS, Athens, GA, ³University of Georgia, Athens.

Leptin concentrations in serum and milk were assessed for Yorkshire x Landrace sows (parity = 2) that were classified as FAT (over 25 mm; n = 7), MEDIUM (20 to 25 mm; n = 8) or THIN (less than 20 mm; n = 9) based on last-rib backfat thickness measured ultrasonically immediately after farrowing. Body weight (kg) and backfat thickness (mm), differed ($P < .001$) among FAT (236.3 ± 4.4 and $28.1 \pm .9$, respectively), MEDIUM (235.5 ± 6.0 and $22.4 \pm .3$, respectively) and THIN (217.9 ± 6.5 and $15.5 \pm .8$, respectively) sows. Loss of backfat (mm) from farrowing to weaning ($21.7 \pm .5$ d of lactation) differed among groups ($P < .01$) and was 6.7 ± 1.1 , $4.7 \pm .6$, and 1.8 ± 1.0 , for FAT, MEDIUM, and THIN sows, respectively. Within 24 h after farrowing, on d 7 and d 14 of lactation, and on the day of weaning, blood samples were collected via jugular venipuncture, and milk samples were obtained following i.m. administration of 1.5 cc oxytocin. At farrowing, serum concentrations of leptin were higher ($P < .01$) for FAT sows ($4.9 \pm .2$ ng/mL) compared to MEDIUM ($3.7 \pm .2$ ng/mL) or THIN ($2.8 \pm .2$ ng/mL) sows, and across groups, serum leptin levels were correlated ($r^2 = .67$; $P < .01$) with backfat thickness. Concentrations of leptin in serum decreased ($P < .01$) by d 7 of lactation in FAT (to $3.2 \pm .2$ ng/mL) and MEDIUM (to $2.8 \pm .2$ ng/mL) sows but remained at similar levels ($P > .1$) throughout lactation in THIN sows. At weaning, serum leptin levels were similar ($P > .1$) among groups and were $2.7 \pm .1$ ng/mL. Concentrations of leptin in whole milk were not affected ($P > .1$) by body condition or stage of lactation and overall averaged 30.5 ± 3.0 ng/mL. In whole milk, levels of leptin and lipid content (81.2 ± 9.1 mg/mL) were not correlated ($r^2 = .25$; $P > .1$). There was no effect ($P > .1$) of body condition on skim milk leptin concentrations. Among groups, leptin levels in skim

milk decreased ($P < .01$) from farrowing (21.0 ± 1.0 ng/mL) to d 7 of lactation (14.4 ± 1.0 ng/mL) and remained at similar levels ($P > .1$) for the remainder of lactation. In summary, circulating, but not whole or skim milk, leptin concentrations are related to adiposity in lactating sows. The physiological role of leptin in the postpartum female warrants investigation.

Key Words: Leptin, Body Condition, Sows

861 Effect of leptin on release of luteinizing hormone from bovine anterior pituitary cells in vitro. T.D. Ridgway^{*}, R.P. Wettemann, and L.J. Spicer, Oklahoma Agricultural Experiment Station, Stillwater.

Enzymatically dispersed bovine anterior pituitary cells were used to determine the effects of leptin on release of luteinizing hormone in vitro. Steer pituitaries were obtained immediately after slaughter on two days (reps). Connective tissue was removed from pituitaries and slices of tissue were exposed to collagenase. Cells (approximately 100,000/well) were plated in 24-well culture plates and incubated at 38.5° C with 95% air and 5% CO₂. Dulbecco's modified Eagle medium with 2% newborn calf serum, 2% glutamine and antibiotics was used for culture of cells. After 72 h of incubation, medium was removed and plates were rinsed three times with medium and cells were treated with 0, 10^{-10} , 10^{-9} or 10^{-8} M concentrations of recombinant mouse leptin (Exposure I). After 4 h, medium was removed and frozen for LH analysis and new medium without leptin was added. After 20 h, medium was removed and frozen (post-leptin) and the same leptin treatments were given. After 4 h, the medium was removed and frozen (Exposure II). Leptin at 10^{-8} and 10^{-9} M suppressed LH release ($P < .002$) by 42% and 35%, respectively, compared with control cells during rep 1 of Exposure I. However, during rep 2 leptin did not alter LH release. During the 20 h post-leptin incubation, LH release was 35% greater from previously leptin treated cells than from control cells ($P < .0001$). Exposure II with leptin, in both reps, for 4 h resulted in a 41% decrease of LH release ($P < .002$) compared with control cells. The decrease in LH release during exposure to leptin followed by increased LH release after leptin treatment was removed indicates that leptin directly affects the release of LH by bovine pituitary cells.

Key Words: Bovine, Leptin, Luteinizing Hormone

862 Relationship of leptin and puberty in performance-tested bulls. T. M. Towns^{*1}, F. N. Schrick¹, F. M. Hopkins¹, F. D. Kirkpatrick¹, A. M. Saxton¹, K. W. Thompson¹, M. E. Hockett¹, and C. S. Whisnant², ¹University of Tennessee, Knoxville, ²North Carolina State University, Raleigh.

The relationship of leptin and onset of puberty was assessed in Angus bulls at the University of Tennessee Bull Performance Evaluation Center. Sixty one bulls (SR, n = 24, 273.9 ± 5.4 d of age; JR, n = 37, 237.0 ± 4.4 d of age) with a scrotal circumference (SC) less than 28 cm were allotted to a 112-day test. Bulls were acclimated for two weeks prior to test following arrival in July (SR) and September (JR). Bulls were fed a diet containing 70% TDN. Blood samples for concentrations of serum leptin and testosterone and measurements of BW, backfat (BF), rumpfat (RF), and SC were collected on days -14 (arrival), 0 (on-test), 28, 56, 84, and 112 (off-test). On-test SC was smaller in JR ($23.5 \pm .3$ cm) than SR bulls ($25.7 \pm .4$ cm; $P < .001$); however, on-test BW (324.9 ± 5.7 kg), BF ($2.8 \pm .3$ mm) and testosterone concentrations ($2.6 \pm .4$ ng/mL) were similar between bull types. Concentrations of leptin were lower in JR ($2.5 \pm .3$ ng/mL) at d 0 than SR bulls ($3.5 \pm .3$ ng/mL; $P < .05$). Bulls were considered pubertal when SC ≥ 28 cm. Age at puberty was lower in JR (281.7 ± 4.9 d) than SR bulls (323.6 ± 6 d; $P < .001$). At puberty, bull types were similar in BW (408.5 ± 9.0 vs. 421.3 ± 11.1 kg), BF ($5.7 \pm .2$ vs. $5.6 \pm .3$ mm), and RF ($7.4 \pm .4$ vs. $7.1 \pm .5$ mm) for JR and SR bulls, respectively. Concentrations of testosterone tended to be higher at puberty in JR ($6.3 \pm .5$ ng/mL) than SR bulls ($4.8 \pm .7$ ng/mL; $P = .09$). Leptin also tended to be higher in JR compared to SR bulls at puberty ($3.5 \pm .3$ vs. $2.6 \pm .3$ ng/mL, respectively; $P = .07$). At d 112 (off-test), SR bulls had larger SC than JR bulls ($36.4 \pm .5$ vs. $34.8 \pm .4$ mm, respectively; $P < .001$); however, backfat ($11.1 \pm .3$ mm) and BW (540 ± 5.7 kg) did not differ between bull types. In conclusion, leptin and testosterone concentrations tended to differ at

onset of puberty between JR and SR bulls; however, body weight and fat measurements were similar.

Key Words: Bulls, Puberty, Leptin

863 Developmental changes in the gene expression of the long form leptin receptor (Ob-Rl) and related neuropeptides in the pig hypothalamus. J. Lin¹, J.B. Barrett², C.R. Barb², R.R. Kraeling², G.J. Hausman², and G.B. Rampack¹, ¹Department of Animal and Dairy Science, University of Georgia, Athens, ²USDA, Agricultural Research Service, Athens, GA.

The hypothalamus is the key site of central regulation of energy homeostasis, appetite and reproduction. The Ob-Rl is localized within the hypothalamus along with several other neuropeptides that are involved in regulation of the neuroendocrine axis. In the present study, developmental changes in gene expression of the Ob-Rl, preprorelin, proopiomelanocortin (POMC), corticotropin releasing factor (CRF), somatostatin, gonadotropin releasing hormone (GnRH) in the hypothalamus was studied. Hypothalami were collected from 106 d-old fetus (n=3) and 7 d-old (n=3), 3.5 month-old (n=3) and 6 month-old (n=2) gilts and expression of Ob-Rl and neuropeptide mRNA examined by semi-quantitative RT-PCR. In addition, back fat leptin mRNA expression in the first three ages was examined. Leptin mRNA expression increased (P<.05) by 7d postnatal, but Ob-Rl mRNA expression increased (P<.05) by 3.5 month. Expression of preprorelin, somatostatin and GnRH mRNA peaked by 3.5 months of age (P<.05) while POMC mRNA expression increased markedly (P<.01) by 6 months of age. The CRF mRNA expression did not change across ages. These findings suggest that Ob-Rl and hypothalamic neuropeptides are associated in development of the neuroendocrine axis in the gilt.

Key Words: leptin receptor, pig, development

864 The insulin-like growth factor system and leptin: role as possible metabolic signals for regulating puberty and growth in dairy heifers. G. Luna-Pinto*¹ and P. B. Cronje¹, ¹Department of Animal and Wildlife Sciences, University of Pretoria.

The aim of this experiment was to study how changes in the blood concentrations of insulin-like growth factor-1 (IGF-1), IGF binding proteins (IGFBP), and leptin mediate the effects of food restriction and compensatory growth on the age of puberty in heifers. Friesian heifers were allocated to one of two dietary treatments. Treatments were designed to result in two different growth rates during the first 13 weeks of the experiment: 0.3 kg/d (restricted treatment) or 0.6 kg/d (control treatment). From weeks 14 to 30, the restricted group received the same amount of food as was fed to the control group. Heifers in the control treatment reached puberty sooner (P < 0.01) than the restricted group (43.8 +/- 0.75 wk. vs 47 +/- 0.63 wk). Mean body weight at puberty was 256.3 +/- 5.22 kg and was not affected by treatment (P > 0.05). Growth rate differed between treatments (P < 0.01) from week 0 to 25. By the end of the restriction period there were differences (P < 0.01) between dietary treatments for plasma leptin, IGF-1 and IGFBP-3 concentrations. Leptin concentration was higher (P < 0.01) in the control group animals than in the restricted animals at weeks 7, 13, 15, 17 and 21. Within the control group, there was a sequential increase (P < 0.01) in plasma leptin concentration between weeks 0, 7, 13, 15 and 17 respectively. Plasma IGF-1 concentration was higher in the control group than in the restricted group at the end of the restriction phase. Higher IGF-1 concentrations were observed in the restricted group during week 15, when growth rates were at their highest (P < 0.01). Plasma IGFBP-3 concentration increased (P < 0.05) during compensatory period from week 13 until week 21. The present results show that concentration of IGF-1 and IGFBP-3 were directly affected by the restriction program, suggesting that these factors may be involved in mediating the effects of nutrition on the onset of puberty.

Key Words: Compensatory growth, Puberty, Insulin-like growth factor system

865 The short-term feeding responses by the changes of amino acid concentrations in plasma and brain. B.W. Kim*¹, C.H. Kim¹, J.S. Shin¹, and H. Tanaka², ¹Kangwon National University, Korea, ²Utsunomiya University, Japan.

This study examined the mechanism of feed intake regulation by investigating the relationship between the amino acid (AA) concentrations in feed and those in plasma as well as brain-prepyriform cortex (PPC). Forty male Wistar rats averaging 140g were randomly assigned into the 9 dietary treatment groups and the 1 control group, with 4 rats in each group. After a 10-day adaptation period, the 9 treatment groups were fed an amino acid-balanced diet for 11 days followed by an amino acid-imbalanced diet which lacks one essential AA in each group. Control group was fed only the amino acid-balanced diet. The feed intake and the AA concentrations in plasma and PPC were measured during the periods in which both amino acid-balanced and -imbalanced diets were fed. Overall, the results indicated that the AA concentrations in plasma and PPC were decreased when the amino acids-imbalanced diets were fed. Specifically on the first day of diet change, the reduction of initial feed intake was greatest in the group with methionine-limited diet and least in the group with threonine-limited diet. On the 3rd day of diet change, in comparison with control, the reduction of feed intake was 71% in the group with histidine-limited diet, 68% in leucine, 66% in isoleucine, 63% in threonine, 61% in tryptophan, 55% in valine, 52% in phenylalanine, 51% in methionine, and 44% in lysine, respectively. The lysine concentrations in plasma and PPC significantly (P<0.05) decreased 2 hours after replacing the amino acid-balanced diet with the lysine-limited diet. These results suggest that the short-term feed intake responses are intimately involved in the AA concentrations in plasma and PPC which are derived from the AA concentrations in feed.

Key Words: Amino acids, Prepyriform cortex, Feed intake

866 Effect of selection for milk yield on hepatic gene expression in the Holstein cow: the growth hormone (GH) receptor and insulin-like growth factor-I (IGF-I). B. A. Crooker*, L. S. Ma, W. J. Weber, L. B. Hansen, and H. Chester-Jones, University of Minnesota, St. Paul.

Cows from a breeding project initiated in 1964 to develop a stable control line (CL) that represented US breed average in 1964 and a select line (SL) that represented contemporary US Holsteins were used to evaluate changes in hepatic GH receptor and IGF-I gene expression. Milk yield of the two lines currently differs by more than 4,500 kg/305 d lactation. Cows from both lines were housed together in a free stall barn and fed ad libitum diets designed to meet their nutritional requirements. Hepatic biopsy samples were obtained from multiparous (10 CL and 13 SL) and primiparous (8 CL and 8 SL) cows at -12 ± 1 (range -1 to -29), 20 ± 0.4 (range 16 to 24) and 68 ± 0.5 (range 63 to 76) d postpartum (PP). Ribonuclease protection assays were conducted to determine GH receptor and IGF-I gene expression. Gene expression results are presented as pixel density relative to an internal control (GADPH) and were analyzed as repeated measures using PROC MIXED of SAS. Milk yield of primiparous and multiparous CL cows was 18.7 and 28.4 kg/d while SL cows produced 29.9 and 44.6 kg/d. Expression of the genes for the liver specific GH-1A receptor (1.67^a, 1.38^b, 1.64^a) and for IGF-I (0.69^a, 0.49^b, 0.65^a) were less (P < 0.001) at 20 d PP than at -12 d PP and returned to prepartum amounts by 70 d PP. Parity did not affect expression of these genes. The SL and CL cows expressed similar amounts of the IGF-I gene. Expression of the liver specific GH-1A receptor was less in SL than CL cows at -12 (1.55, 1.79; P = 0.08) and 20 (1.23, 1.52; P = 0.04) d PP, similar at 68 (1.59, 1.69) d PP and less (P = 0.04) during the overall study (1.46, 1.67). Expression of the common GH-1B receptor was not affected by genetic line, parity, or day of lactation. These results indicate selection for milk yield has reduced expression of the liver specific GH-1A receptor during the periparturient period but has had no effect on expression of the genes for IGF-I or the GH-1B receptor.

Key Words: Genetic Selection, Gene Expression, Dairy Cattle

867 Evaluation of insulin receptor mRNA levels at different days pre and postpartum in liver tissue of genetically selected dairy cattle. J.A. McMullen*¹, J.H. White¹, J.R. Knapp¹, W.J. Weber², H. Chester-Jones², L.B. Hansen², and B.A. Crooker², ¹University of Vermont, Burlington, ²University of Minnesota, St. Paul.

The objective of this study was to clone the bovine insulin receptor cDNA and quantitatively analyze the expression levels of bovine insulin receptor mRNA in liver tissue. The hybridization probe was cloned using primers designed from homologous regions in human and mouse insulin receptor cDNAs. A 287 base pair clone was isolated and sequenced and found to be 95% homologous to the mouse insulin receptor cDNA at the DNA level and 100% homologous at the amino acid level. This bovine specific clone was then used to evaluate the expression levels of mRNA in liver tissue biopsied from two lines of dairy cows from the Waseca Experiment Station, University of Minnesota. The control line has been genetically maintained at the 1964 Predicted Transmitting Abilities (PTA) for milk production by being bred in a rotating fashion to the same 20 bulls. The select line has been bred each year to sires with the top 1% PTA for milk production and there is now a 12,000 lbs milk yield difference between the two lines. Liver biopsies were taken from 5 cows in each line at 14d prepartum, 14, 21 and 70d postpartum and an equal amount of tissue from each cow within a group were pooled together. Total RNA was isolated, purified, and analyzed by Northern blotting hybridization techniques. mRNA expression levels were quantified using a STORM phosphorimager system. No significant differences were found in the expression levels of insulin receptor mRNA between the two lines. However, there was an interaction between the stage of gestation/lactation and line. mRNA levels for insulin receptor tended to be higher than those of controls at 14d prepartum ($p \leq 0.10$). The RNA of the individual cows that made up the pooled samples were analyzed and were found to contribute 3.8 - 38.1% of the variation in the pooled control samples and 8.7 - 22.5% in the pooled select samples. Genetic selection of dairy cattle alters expression levels of the liver insulin receptor in late gestation; however, this change was not observed in lactation.

Key Words: Insulin Receptor, Lactation, Dairy Cattle

868 Effect of bST and monensin on lipogenesis and gene expression in adipose tissue during the transition to calving. S.S. Donkin*¹, C. Agca¹, A. Arieli², J.E. Vallimont³, and G.A. Varga³, ¹Purdue University, West Lafayette, IN, ²Hebrew University of Jerusalem, Israel, ³Pennsylvania State University, University Park, PA, USA.

Enhancing lipogenesis to counteract adipose tissue mobilization in late gestation may serve to alleviate the metabolic pressures experienced by the transition dairy cow. To test this possibility the effects of prepartum monensin (300 mg/head), somatotropin (bST), and their combination were measured on lipogenesis and gene expression in dairy cattle. Beginning 28 d prior to expected calving 30 multiparous Holstein cows were assigned to either a control (n=10), monensin (n=6), bST (n=7), or monensin and bST (n=7) treatment groups. The bST (POSILAC, 500 mg) was injected 28-d and 14-d prior to calving. Adipose tissue biopsies were obtained on -14 days and +14 days relative to calving. Lipogenesis (nmol [¹⁴C] acetate incorporated into total lipid · g tissue⁻¹ · 2 h⁻¹) was determined using explant cultures. Total RNA extracted from adipose tissue was analyzed for fatty acid synthase (FAS), acetyl-CoA carboxylase (ACC), growth hormone receptor (GHR), and leptin mRNA. Lipogenesis was 5 percent of prepartum levels at 14 days of lactation (6464 and 30; prepartum vs postpartum) and was increased prepartum by bST (2186 vs 4307) and monensin (1663 vs 4831) but these effects were not additive. The effects of bST were sustained through calving. Treatments did not alter ACC or FAS mRNA during the prepartum period but ACC and FAS mRNA were decreased to 10 to 20 percent of prepartum levels after calving. Monensin retarded the postpartum decrease in ACC mRNA. The effect of bST to increase GHR mRNA ($P < .10$) is observed at both sampling times. Leptin mRNA was reduced ($P < .05$) by 72 percent after calving but was unaffected by the treatments. The data indicate bST or monensin enhances lipogenesis during late gestation and bST does not change expression of lipogenic genes yet GHR mRNA changes indicate tissue responsiveness.

Key Words: Transition dairy cattle, Adipose tissue, Gene expression

869 Acute effects of estrogen on lactotroph abundance in GH₁, GH₃, GH₄C₁, MMQ and GC pituitary cell lines. X. Fu* and T. E. Porter, University of Maryland, College Park.

Estrogen is a very important regulator of prolactin (PRL) production. Previous work indicated that estrogen could increase lactotroph abundance in GH₄C₁ cells after 2 days of treatment. Recent experiments imply that estrogen might have more rapid effects. The purpose of this study was to explore the existence of short-term effects of estrogen on lactotroph abundance in five pituitary cell lines, GH₁, GH₃, GH₄C₁, MMQ and GC. GH₁, GH₃ and GH₄C₁ secrete both growth hormone (GH) and PRL. MMQ and GC cells secrete only PRL and GH, respectively. All cells were cultured in Ham's F-10 medium, containing 5% charcoal-treated Fetal Bovine Serum, to remove endogenous estrogen. In order to study the short-term effects of estrogen on lactotroph abundance, 4 and 24 hour treatments were evaluated. PRL containing cells were assessed using immunocytochemistry after treatment with estradiol-17β (E₂, 10⁻¹⁰ and 10⁻⁸M). E₂ had no effect on the percentage of PRL containing cells in GC and MMQ cells. For the 24 hour treatment, E₂ increased the percentage of PRL containing cells in GH₁ cells ($P < 0.05$) to 54 ± 1.3% of all cells, relative to the control of 43 ± 1.2%. In GH₃ cells, E₂ increased the PRL containing cells ($P < 0.05$) to 57 ± 0.6%, relative to the control of 46 ± 1.4%. In GH₄C₁ cells, the PRL containing cells increased to 53 ± 1.2% ($P < 0.05$), relative to the control of 34 ± 0.6%. For the 4 hour treatment, E₂ increased the abundance of PRL containing cells in GH₁ cells ($P < 0.05$) to 50 ± 0.9%, relative to the control of 43 ± 1.2%. In GH₄C₁ cells, the population of PRL containing cells increased ($P < 0.05$) to 38 ± 1.4%, relative to the control of 34 ± 0.6%. In GH₃ cells, however, E₂ decreased the population of PRL cells ($P < 0.05$) to 36 ± 1.5% compared to the control of 46 ± 1.4%. The results indicate that estrogen can affect lactotroph abundance following both long-term and short-term treatments. As the percentage of PRL cells increased within 4 hours following E₂ treatment of GH₁ and GH₄C₁ cells, these cell lines will be good models for the rapid recruitment of lactotrophs in response to estrogen.

Key Words: estrogen, prolactin, lactotroph

870 Sensitive sandwich assay for the determination of bovine growth hormone in blood and milk. P. Lovendahl*¹, J. Adamsen¹, R. Lund², and P. Lind², ¹Danish Institute of Agricultural Science, ²Danish Veterinary Laboratory, Denmark.

Monoclonal antibodies against synthetic bovine growth hormone were raised and selected for binding to bGH. The catching mab-GH1 was coated on microtiter plates and used to immobilize bGH to plates. Bound bGH was quantitated by adding labelled mab-GH2 during incubation for 9 hours at 25°C. Labelling of mab-GH2 was either directly with Europium (method A) or with biotin (method B). If biotin was used, a second step followed, where Europium labelled streptavidin was allowed a further 0.5 hours incubation to bind to biotin. Time resolved fluorescence from Europium was read following chelation with an enhancement solution. The sensitivity of the assay is less than 0.1 ng/mL in both blood and milk. Milk and EDTA containing plasma can only be measured by method B, because of interactions between Europium and EDTA. The working range is 0.2 to 200.0 ng/mL (method A), or 0.3 to 30.0 ng/mL (method B). Variation is generally low (CV within assay < 6% at 4 ng/mL; < 3% at 20 ng/mL). Results correlate perfect with RIA results $r > 0.99$. Growth hormone in plasma from sheep and goats can also be measured. We conclude that the developed assay is sensitive, accurate, fast and eliminates the hazards attached to radio labelling.

Key Words: somatotropin, ELISA, bovine

871 Effects of antiserum against adipocyte plasma membrane proteins on body composition of passively immunized Sprague-Dawley rats. K. H. Paik, E. J. Kwon, T. H. Kwak, S. H. Chae, K. K. Jung, and C. B. Choi, Department of Animal Science, Yeungnam University, Korea.

The objectives of the current study were to develop polyclonal antibodies in sheep against adipocyte plasma membrane (APM) proteins isolated from Sprague-Dawley (SD) rat, to investigate tissue specificity, and to determine cytotoxic effects of antiserum on rat adipocyte metabolism *in vitro* and *in vivo*. Plasma membrane proteins from adipocyte, heart, kidney, liver, muscle and spleen of SD rats were isolated using an isotonic sucrose self-forming gradient. Adult male sheep was immunized

three times at three week interval with the purified rat APM proteins. Antisera were taken from immunized sheep at 10, 12, and 14 days after the third immunization. Antiserum expressed strong antigen-antibody reactivity with APM proteins determined by ELISA, and the reactivity could be detected at dilutions in excess of 1:81,000. Tissue specificity of the antisera was confirmed by Western immunoblotting. Although not entirely specific, the antisera demonstrated remarkably higher degree of reactivity with proteins isolated from adipocytes compared with the other tissues. The reactivity of antiserum to the external surface of the fixed rat adipocytes could be confirmed by using a fluorescent material, anti-sheep immunoglobulin G-FITC. Confluent rat adipocytes in culture were lysed by antisera treatment and cytosolic lactate dehydrogenase was released as a dose-dependent patterns while adipocytes treated with non-immunized serum maintained their integrity. Furthermore, passive immunization of male SD rats with antisera significantly ($p < .01$) reduced subcutaneous (21.9%) and perirenal+mesenteric+epididymic (36.0%) adipose tissue mass. These results implicate that the antisera raised against APM proteins isolated from SD rats could be used to reduce body fat contents in meat animals. Further studies, however, are necessary for the practical applications of the current results.

Key Words: Adipocyte, Antiserum, Passive immunization

872 Insulin sensitivity (IS) and endocrine responses to insulin in ewe lambs. S.E. Recabarren, A. Lobos, C. Vilches*, M.J. Nuñez, and P. Muñoz, *Lab. of Animal Physiology and Endocrinology, Fac. Vet Med. Universidad de Concepcion, Chillán, Chile.*

In the growing female sheep, glucose (G) and insulin (INS) may be used as metabolic signals to inform to the GnRH neurons about the metabolic status of the growing sheep. Peripheric IS could change during prepubertal development to allow more G or INS available to the brain. A study was conducted to determine the IS in 20 and 30-week ewe lambs ($n=6$), using the insulin tolerance test, and to explore LH, cortisol (C) and leptin (L) changes in response to insulin. Lambs received an iv bolus of human INS (0.1 IU/kgBW). Blood samples were collected by means of an indwelling jugular vein catheter at 0, 3, 5, 7, 10, 13, 15, 17, 20, 30, 40, 50, 60, 80, 100 and 120 min after INS administration. Plasma G, INS, C were measured in all samples, LH and L in selected samples. IS was calculated using formula $IS = (G_{20} - G_0) / G_0$ where G_0 is G at 0 min and G_{20} is G at 20 min derived from a regression plot. IS was similar at both ages: 0.18 ± 0.03 and 0.17 ± 0.03 . Basal G levels were 0.68 ± 0.03 and 0.72 ± 0.03 (g/l) respectively. G significantly descended after 10 min of INS injection, reached a nadir after 30 min and remained low until 120 min. Plasma C levels decreased after 20 min of INS administration ($P \leq 0.05$) and increased thereafter, with a peak at 80-100 min. Plasma INS increased from 0 to 3 min and returned to basal levels at 120 min. In 20-week lambs, LH increased from 0.44 ± 0.14 at time 0 to 1.6 ± 0.47 ($P \leq 0.05$) at time 30 min. In 30-week lambs, plasma LH reached a peak at 30 min but without statistical significance. Plasma L did not change after INS administration. Results suggest that the IS does not change during prepubertal development but INS had a stimulatory effect on LH secretion even when G levels were low and C was increasing. Supported by DIUC 98.153.009-1

Key Words: Insulin sensitivity, LH, Puberty

873 Effects of colostral immunity on lifetime performance of the female dairy cattle. R. Kliks and R. Skrzypek*, *Agricultural University, Poznan, Poland.*

Concentrations of total protein, globulins and immunoglobulins were measured on the second day of life in blood serum of 327 Black and White females, born on the university farm from 1986 to 1990. The relationships between passive immunity and performance parameters were most evident for immunoglobulins; therefore only results obtained for this trait will be presented. We found significant partial correlation coefficients between concentration of colostral immunoglobulins and the first lactation milk yield ($r = -.26$; $P \leq .01$) as well as calving intervals throughout the period of life (r from $-.20$ to $-.35$; $P \leq .05$ and $P \leq .01$, respectively). As regression analysis showed in many instances presence of significant quadratic effects, three levels of passive immunity were assigned taking in account the first and the third quartiles as limit values; low (L; .4 to 6.0 g/l), medium (M; 6.1 to 22.4 g/l) and high (H; 22.5 to 49.0 g/l). All important lifetime performance traits subjected to the analysis reached the highest values in M group, while the lowest values were in L group. For instance, lifetime milk yield was 13397 kg in L

group, 16682 kg in M group and 14904 kg in H group; and functional length of life was 1628 days in L group, 1848 days in M group and 1782 days in H group. This finding seems to confirm recent reports by other authors, indicating that high intake of maternal immunoglobulins by the newborn calf may have a depressing effect on active humoral immunity acquired during the later period of life. It is concluded, that colostral immunity affects performance of female dairy cattle throughout life.

Key Words: Dairy females, Colostral immunity, Lifetime performance

874 Protein nitrotyrosine residues are associated with the nonmastitic bovine mammary gland. T. K. Ledbetter*¹, M. J. Paape², and L. W. Douglass¹, ¹*University of Maryland, College Park,* ²*USDA-ARS, Beltsville, MD.*

Nitrated tyrosine residues accumulate at sites of inflammation, and are an indicator of the presence of reactive nitrogen species. Nitration of tyrosine residues in bovine blood and mammary polymorphonuclear neutrophils (PMN) and milk proteins during acute mastitis was examined. Blood and milk were collected before and 12 h after intramammary injection of 50 g *Escherichia coli* lipopolysaccharide (LPS) ($n = 3$ cows), and milk was collected after oxytocin injection. Nitrotyrosine residues in isolated PMN lysates and whey proteins were visualized by immunoblotting and quantitated by ELISA. Binding of the anti-bovine PMN mAb 36H10 (used as a positive control) to blood and milk PMN induced tyrosine phosphorylation and reversed tyrosine nitration after 20 s. Blood and milk PMN lysates had moderate and high levels, respectively, of nitrotyrosine before LPS injection. Nitrotyrosine levels tended to decrease in blood PMN ($p < 0.2$) and decreased significantly in milk PMN ($p < 0.001$) 12 h after LPS injection. Phosphotyrosines in blood and milk PMN increased after LPS injection. Nitrotyrosines and phosphotyrosines were present in whey proteins before injection. Tyrosine nitration of milk proteins decreased significantly in whey 12 h after LPS injection ($p < 0.05$) and remained low in residual milk. Milk protein tyrosine phosphorylation increased 12 h after LPS injection and remained elevated in residual milk. In a second experiment, the statistical relationship between whey protein nitrotyrosine concentration and somatic cell count (SCC) was determined using composite milk from 42 cows. Nitrotyrosine concentration was negatively correlated with $\log_{10} SCC$ ($p < 0.001$). Tyrosine nitration in blood and milk PMN and whey proteins was associated with gland normality and low SCC. Tyrosine nitration in bovine PMN is reversible, and may represent the normal state of many proteins in whey and PMN.

Key Words: Nitrotyrosine, Mastitis, Polymorphonuclear neutrophil

875 Evaluation of udder health using differential inflammatory cell count. S. Pillai*, B. Jayarao, S. Senh, E. Kunze, K. Shafer-Weaver, and L. Sordillo, *Pennsylvania State University, University Park.*

A flow cytometric technique called Differential Inflammatory Cell Count (DICC) to identify leucocyte cell types was standardized using monoclonal antibodies to leucocyte cell surface antigens CD3, CD11b and CD18. DICC was then evaluated using individual quarter milk samples from 13 cows. Cows were sampled at weekly intervals for 3 weeks and total cell count (TCC), Lymphocyte/Monocyte count (LMC), and polymorphonuclear cell count (PMNC) were determined and compared to somatic cell count (SCC). There was a strong positive correlation between SCC and TCC ($r=0.8, 0.76, 0.76$ at day 1, 7, 14 respectively). TCC was also observed to be positively correlated with PMNC ($r=0.96, 0.93, 0.9$ at day 1, 7, 14 respectively). A consistent and significantly higher mean TCC (3.76, 3.86, 3.86 log units respectively) and PMNC (3.32, 2.85, 3.45 log units respectively) was observed in quarters with SCC > 5.4 log units as compared to quarters with SCC < 5.4 log units (TCC 2.95, 2.8, 3.23 log units respectively and PMNC 2.05, 1.41, 2.63 log units respectively). Quarters with high TCC and PMNC also had a higher number of quarters that were culture positive (62 - 87%) as compared to quarters with low TCC and PMN (37-51%). The findings of the study suggest that DICC has the potential to evolve as a new technique for evaluation of udder health status in dairy herds.

Key Words: Differential inflammatory cell count, somatic cell count, total cell count

876 Expression of angiogenic growth factors throughout lactation and during the dry period. L. Varticovski¹, A.V. Capuco², and R.A. Christensen*¹, ¹St. Elizabeth's MC, Tufts U. School of Medicine, Boston, MA, ²USDA-ARS, Beltsville, MD.

A non-lactating "dry" period of 40-60 days prior to parturition is required to maximize milk production in the subsequent lactation. Without this dry period, milk production may be reduced by as much as 20%. The mechanism whereby the dry period is required for subsequent maximal milk production is unknown. Angiogenic growth factors, including vascular endothelial growth factor (VEGF), angiopoietin 1 (Ang 1) and angiopoietin 2 (Ang 2) levels increase as a result of hypoxia during wound healing, tumor development and other conditions which are associated with new blood vessel development. We hypothesize that angiogenic growth factors and their receptors will be elevated during the dry period. RT-PCR was performed after total RNA isolation from samples obtained from dairy cows which were in early (n=3), mid (n=3), late (n=3) lactation (14, 120, and 300 days, respectively) or 40 days into the dry period (n=3). Data were analyzed by ANOVA and treatment means were compared by Bonferroni test. Expression of β -actin was used as the control. We amplified all four isoforms [121, 165, 189, and 206 amino acids (aa)] of VEGF. The freely soluble isoform (121 aa) was similar ($P > .2$) in cows at different stages of lactation and the dry period. There was a tendency ($P = .14$) for a difference in the cell surface and extracellular matrix bound isoform (165 aa). The two isoforms which bind almost exclusively to the extracellular matrix (189 and 206 aa) also tended ($P < .08$ and $.09$, respectively) to be different. The differences in 165, 189, and 206 aa isoforms of VEGF primarily resulted from higher expression of these isoforms in non-lactating cows when compared to cows in late lactation. Ang 1 and 2 and their receptor, Tie2, expression was also highest in non-lactating cows. In conclusion, the changes in VEGF, Ang 1, Ang 2, and Tie2 receptor support the hypothesis that hypoxia, which is associated with involution, stimulates production of angiogenic growth factors. These data suggest that angiogenic growth factors may play an important role in the development of the microvascular network in the mammary gland during involution.

Key Words: Mammary, Angiogenesis, Vascular endothelial growth factor

877 Dopamine antagonist affects cortisol secretion in lactating dairy cows. A. Ahmadzadeh*, M. A. Barnes, F. C. Gwazdauskas, and A. H. Walters, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

The role of dopamine in regulation of glucocorticoid secretion was investigated by characterizing serum cortisol response to fluphenazine (FLU), a dopamine receptor antagonist, in lactating dairy cows. In Exp. 1, 12 anovulatory primiparous cows received (i.v.) either saline (SAL; n=6) or .3 mg/kg BW FLU (n=6) in wk 2 postpartum. Blood samples were collected every 30 min for 4 h before and 4 h after SAL or FLU. In Exp. 1, mean serum progesterone concentration was $.13 \pm .1$ ng/ml and there was no difference in mean serum cortisol concentrations between groups before treatments (5.9 ± 2.0 in FLU vs 6.9 ± 2.0 ng/ml in SAL). FLU caused an increase ($P < .01$) in mean serum cortisol concentration (from 5.9 ± 2.0 to 18.2 ± 2.0 ng/ml) in primiparous cows. Serum cortisol level increased within 30 min after FLU administration and remained elevated throughout the sampling period. Mean serum cortisol remained unchanged in SAL-treated cows (6.9 ± 2.0 before vs 4.0 ± 2.0 ng/ml after SAL). To eliminate possible parity effects that may have confounded Exp. 1, a second experiment was conducted. In Exp. 2, 6 anovulatory multiparous cows (wk 2 postpartum) were used and all cows received FLU (.3 mg/kg BW). Experimental procedures were the same as used in primiparous cows. In Exp. 2, mean serum progesterone concentration was $.12 \pm .05$ ng/ml. Similar to Exp. 1, FLU increased ($P < .01$) mean serum cortisol concentration (from 13.2 ± 6.5 to 45.4 ± 6.5 ng/ml) in multiparous cows. These results indicate the stimulatory role of dopamine antagonist in cortisol secretion regardless of parity and presumably by affecting pituitary ACTH secretion, and suggest that endogenous dopamine, at least in part, regulates cortisol secretion in lactating dairy cows.

Key Words: Dopamine, Glucocorticoids, Dairy cow

878 Dexamethasone treatment at birth enhances neonatal growth in swine. J.A. Carroll* and R.L. Matteri, Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.

Previously, we have reported that elimination of the periparturient events associated with the natural birth process through caesarian delivery reduces average daily gain (ADG) and serum concentration of insulin-like growth factor 1 (IGF-1; J Anim Sci 76 (Suppl 1):126, 1998). Therefore, the objective of the present study was to determine if dexamethasone (Dex; a potent synthetic glucocorticoid) treatment at birth would alter postnatal growth in neonatal pigs. Forty crossbred pigs were injected i.m. with either sterile saline (Cont; n=10 males and 10 females) or Dex (1 mg/kg; n=10 males and 10 females) within 1 hr of birth. All pigs remained with their respective dams until 18 d of age. Body weights were recorded weekly and on d 18. On d 17, all pigs were non-surgically fitted with an indwelling jugular catheter and placed back with the sows. On d 18, all pigs were placed in individual pens for serial blood collection. Birth weights ($1.53 \pm .04$ kg) did not differ between birth treatments or sex classes ($P > 0.70$ and 0.89 , respectively). A time by birth treatment effect was detected ($P < 0.007$) for body weight such that those pigs which received Dex at birth had the greatest body weights during the 18-day period. Average daily gain was increased ($P < 0.017$) by 12.2% in those pigs which received Dex at birth ($.286 \pm .007$) as compared to the Cont pigs ($.255 \pm .01$ kg/day). Serum concentration of IGF-1 was influenced by both birth treatment ($P = 0.0006$) and sex class ($P < 0.017$). In the male pigs, Dex increased ($P = 0.02$) serum concentration of IGF-1 by 40.5% as compared to Cont male pigs, whereas in the females, Dex increased ($P < 0.007$) serum concentration of IGF-1 by 33.5% as compared to Cont female pigs. Based on the results of the present study, as well as previous reports from our laboratory (J Anim Sci 76 (Suppl 1):99, 1998; J Anim Sci 76 (Suppl 1):126, 1998), the early neonatal period may be an opportune time to permanently alter physiological factors which influence the growth biology of swine. Also, the present study indicates that early neonatal hormonal therapies may be useful in achieving the actual genetic potential for growth in pigs.

Key Words: Neonatal Pigs, Dexamethasone, Growth

879 Estradiol/progesterone treatment inhibits nitric oxide production in endotoxemic cattle. J. L. Sartin*, T.H. Elsasser², S. Kahl², D.D. Schwartz¹, J. Baker¹, M.A. Shores¹, and B. Steele¹, ¹Auburn University, ²ARS/USDA.

Estradiol/progesterone (EP) implants have been shown to decrease clinical signs of pathologic responses of cattle to coccidiosis and endotoxemia. We proposed that EP acts to minimize effects of endotoxemia in cattle through a reduction of nitric oxide (NO) production, a key step in mediating cytokine actions on target tissues. Holstein steers were divided into 4 groups: control, EP, endotoxin, and EP-endotoxin (n=5/group). Cattle were provided EP implants (Synovex S; Ft. Dodge) at 4 mos. of age and one week later injected with endotoxin (0.6 μ g/kg BW; Sigma). Body temperature was measured at 0, 2, 4, 6, and 8 h. Plasma was collected at time 0 and hourly thereafter for 8 h and assayed for nitrate/nitrite (stable end product of NO metabolism), prostacyclin, cortisol and tumor necrosis factor (TNF). Body temperature was increased in both endotoxin and endotoxin-EP calves, but had returned to normal by 6 and 8 h in the endotoxin-EP group ($P < 0.05$). Plasma nitrate/nitrite levels were elevated ($P < 0.01$) in calves treated with endotoxin alone, whereas treatment with EP blocked the endotoxin-mediated increase in plasma nitrate/nitrite levels. Plasma TNF and cortisol concentrations were increased by endotoxin ($P < 0.01$), but were unaffected by EP. Likewise, EP did not affect the increases in endotoxin-induced prostacyclin concentrations, indicating EP does not affect this indicator of oxidative stress. These data indicate that EP can reduce the production of NO in calves stimulated with endotoxin. The mechanism for this inhibition is not known, but based on in vitro studies in lymphocytes and with studies of the hypothalamus, EP would be expected to inhibit NO synthase activity and/or synthesis.

Key Words: endotoxin, nitric oxide, estradiol

880 Neonatal Quipazine treatment induced a cortisol release in pigs but did not increase hippocampal glucocorticoid receptor levels. S Weaver*¹ and M.J.M. Meaney², ¹Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN, ²Douglas Hospital Research Centre, Montreal, Quebec, Canada.

Improved well-being for swine in commercial production would result from decreased exposure to or response to stressors. In the rat, hippocampal glucocorticoid receptors (GR) regulate the duration of stress responses. The number of GRs in the hippocampus of the rat is positively regulated by the serotonin agonist quipazine in vitro. Postnatal antagonism of serotonin signaling prevented neonatal handling-induced increases in hippocampal GR in the rat. The objectives of this study were: 1) to determine if in vivo quipazine administration would alter GR levels in the hippocampus of neonatal pigs, 2) induce a cortisol release, and 3) affect body weights prior to weaning. Eight litters of PIC pigs were assigned to one of 3 doses of quipazine dissolved in saline: 0, .5, 1.0, 2.0 mg/kg (n=16 pigs per treatment) which was balanced across sex and litter. Subcutaneous injections were given for the first 7 days of life. On day 5 blood samples were obtained. At 14 days of age 2 males and 2 females from each treatment were euthanized and the pituitary gland, frontal cortex, hypothalamus and hippocampus were collected. Data were analyzed as a split-plot design with sex as the whole plot, drug treatment as the sub-plot and litter as the replication followed by Student-Newman Keuls post hoc tests. A dose related cortisol response to quipazine administration was detected with significantly higher ($P < .05$) plasma cortisol levels in pigs given 2.0 compared to .5 or 0 mg/kg quipazine (2.0 mg 21.22 ± 2.40 ; .5 mg 12.50 ± 2.07 ; 0 mg 11.39 ± 1.16). There was no significant effect of quipazine on immunoreactive GR levels as determined using western blotting. Weekly body weights, up to 28 days of age, were not affected by quipazine treatments. In conclusion, hippocampal GR levels were not altered by postnatal administration of quipazine. Quipazine administration did induce a cortisol release in neonatal pigs that did not alter body weights prior to weaning.

Key Words: Glucocorticoid receptor, Serotonin, Neonate

881 Molecular cloning of bovine corticotropin releasing factor receptor 1 (CRFR1) cDNA: Tissue distribution and regulation of CRFR1 mRNA expression in the anterior pituitary of endotoxemic steers. I.M. Qahwash*, C.A. Cassar, R.P. Radcliff, and G.W. Smith, Michigan State University, East Lansing.

Actions of corticotropin releasing factor (CRF) in rodents are mediated through two distinct receptor subtypes, CRFR1 and CRFR2, which differ in pharmacological properties and distribution within the brain and peripheral tissues. The distribution, regulation, and physiological roles of specific CRF receptor subtypes in cattle are unknown. Our objectives were to clone and sequence a bovine CRFR1 cDNA, to characterize distribution of CRFR1 mRNA in the brain and peripheral tissues, and to examine CRFR1 mRNA regulation in the anterior pituitary (AP) during systemic inflammatory stress. A 1,248 bp cDNA encoding the entire CRFR1 open reading frame was isolated from bovine AP and sequenced. The nucleotide and predicted amino acid sequence of bovine CRFR1 was 89 and 95% similar to the rat CRFR1. A prominent 2.5 kb CRFR1 mRNA transcript and a second 8.0 kb minor transcript were detected in specific regions of the brain including the cerebellum, cerebral cortex and hypothalamus, and also in the AP. Expression was not detected in peripheral tissues tested (liver, spleen, heart, kidney, and adrenal gland). We then examined the regulation of CRFR1 mRNA expression in AP collected from Holstein steers at 0, 2 and 4 h after bacterial endotoxin administration (n = 8). All endotoxin treated animals responded with the increase in body temperature and elevation of plasma ACTH and cortisol characteristic of a systemic inflammatory response. AP CRFR1 mRNA decreased by 4 h after endotoxin administration ($P = 0.003$). In summary, bovine CRFR1 mRNA was detected in specific brain regions but not in the periphery. Expression in AP was decreased during systemic inflammatory stress. The contribution of CRFR1-mediated pathways to specific components of the stress response in cattle awaits further investigation.

Key Words: Corticotropin releasing factor receptor 1, Bovine anterior pituitary, Stress

882 Relationships of plasma cortisol and corticosteroid-binding globulin (CBG) concentrations, and hepatic CBG mRNA expression levels in fetal and postnatal pigs. J. Heo*¹, H. G. Kattesh¹, R. L. Mattered², and M. P. Roberts¹, ¹University of Tennessee, Knoxville, ²Animal Physiology Unit, Agricultural Research Service, USDA, Columbia, MO.

The concentration of CBG in circulation is determined by hepatic synthesis, peripheral degradation, and/or transfer to the extravascular system. The purpose of this study was to evaluate the relationships among hepatic CBG mRNA expression and plasma concentrations of cortisol and CBG during fetal and postnatal periods in the pig. A partial CBG cDNA (500bp) probe was developed from porcine liver RNA using RT-PCR. The PCR product was subcloned into the pGEM-T easy vector. The porcine partial CBG cDNA sequence showed 77% and 82% homology with human and sheep CBG cDNA, respectively. Blood and liver tissue were collected from fetal pigs (n=7-14) on d 50, 70, 80, 90, and 104 of gestation, as estimated by fetal length, and from postnatal pigs (n=7-8) on d 1, 3, 10, 20, 30, and 40 following birth. Plasma cortisol and CBG concentrations were determined by RIA and ELISA, respectively. Total RNA was isolated from liver tissue. Levels of CBG mRNA were determined by Northern blot analysis and expressed relative to β -actin. In fetal pigs, CBG mRNA expression was highest ($p < .005$) on d 50 compared to d 90 exhibiting a negative relationship ($r = -.63$, $p < .001$) with estimated fetal age. Plasma CBG concentrations were correlated ($r = .90$, $p < .01$) to CBG mRNA levels. Plasma cortisol concentrations were not different over this same period. In postnatal pigs, CBG mRNA expression increased ($p < .001$) from d 3 to d 40. Plasma CBG concentration increased ($p < .001$) from d 1 (6.07 ± 3.37 ug/ml) to d 10 (15.15 ± 3.72 ug/ml). Plasma cortisol concentrations remained constant. The present study represents the first determination of the relationship between the abundance of hepatic CBG mRNA and circulating CBG concentrations in the pig. An understanding of these relationships provides an important fundamental understanding of the mechanism determining the bioavailability of cortisol necessary in prenatal development and the conservation of cortisol during postnatal development.

Key Words: CBG, Cortisol, Fetal and postnatal pig

883 Adrenocortical function in nutritionally restricted female Nubian goats. R. M. Melendez-Soto*¹, M. Gomez-Pasten¹, L. Zapata-Salinas², and H. R. Vera-Avila², ¹FES Cuautitlan-UNAM, Mexico, ²CNIFyMA-INIFAP, Mexico.

To test the effect of nutritional restriction on adrenocortical function, 19 mature female Nubian goats (51 ± 1.2 kg) were randomly assigned to be fed a maintenance diet (NR0, n=5) or to be 20 (NR20, n=7) or 40 % (NR40, n=7) nutritionally restricted. On weeks 9 (early winter), 18 (early spring), 27 (mid-spring) and 36 (early summer) animals were weighed, exposed to transport stress and fitted with jugular catheters for intensive bleeding (IB). BW changes with respect to d0 (BWC) were estimated and compared between treatments. Blood was collected before and after transport and analyzed for cortisol (CT). Differences between pre- and post-transport CT were considered adrenocortical response (CTR). IB was initiated at 5:00 AM and blood samples were collected every 80 min over a 24 h period. Plasma was obtained and analyzed for CT. BW was essentially maintained in NR0 and gradually decreased in NR20 and NR40 ($-5.5 \pm .25$, $-1.2 \pm .31$, $-.8 \pm .63$ and $+4.4 \pm .22$, $-2.2 \pm .35$, $-3.4 \pm .69$, $-3.2 \pm .84$ and $-4.0 \pm .96$, $-4.4 \pm .63$, $-7.3 \pm .87$, $-7.7 \pm .97$ and -11.7 ± 1.1 kg BWC for NR0, NR20 and NR40 on weeks 9, 18, 27 and 36; treatment x week, $P < .001$). CTR was affected by week ($P = .02$) but not by treatment or treatment x week ($P > .05$). A random variation between weeks was observed on CTR ($4.4 \pm .42$, $3.6 \pm .37$, $4.3 \pm .40$ and $3.3 \pm .28$ ng/ml for weeks 9, 18, 27 and 36). Mean CT during IB was affected by week ($P < .01$) but not by treatment or treatment x week ($P > .05$). A significant increase in mean CT was observed on weeks 18 and 27 as compared to weeks 9 and 36 ($1.2 \pm .16$, $1.7 \pm .28$, $1.8 \pm .14$ and $1.1 \pm .13$ ng/ml for weeks 9, 18, 27 and 36). CT profile during IB was affected by week, time and week x time ($P < .01$) but not by treatment or any interaction with treatment ($P > .05$). Peak plasma CT concentrations, which best reflected differences in the week x time interaction during IB were observed between times of collection 2 to 4 ($2.2 \pm .55$, $3.3 \pm .84$ and $2.3 \pm .67$, $3.7 \pm .24$, $3.7 \pm .38$ and $3.6 \pm .50$, $4.8 \pm .45$, $5.0 \pm .35$ and $4.3 \pm .41$, $1.8 \pm .21$, $1.5 \pm .38$ and $1.1 \pm .39$ ng/ml for times 2, 3 and 4 on weeks 9, 18, 27 and 36). Overall, nutritional restriction did not alter adrenocortical function. A trend for a seasonal effect on adrenocortical function was observed.

Key Words: Adrenal Gland, Undernutrition, Goats

884 Influence of *Bos taurus* and *Bos indicus* breed-type on production of cortisol. J.W. Koch^{*1}, T.H. Welsh¹, J.O. Sanders¹, D.G. Riley¹, D. Lunt², J.W. Holloway³, T.D.A. Forbes³, H. Lippke³, F.M. Rouquette⁴, and R.D. Randel⁴, ¹Texas Agricultural Experiment Station, College Station, ²McGregor, ³Uvalde, ⁴Overton.

Both the plasma concentration of cortisol and adrenal gland weight have been reported to be greater for *Bos taurus* (Angus) than *Bos indicus* (Brahman) cattle. The objective of this experiment was to determine if differences exist in proportional response (fold increase) of plasma cortisol following an injection of ACTH (0.1 IU/kg of bodyweight). Full blood *Bos taurus* (BT, n = 58), 3/4 *Bos taurus* - 1/4 *Bos indicus* (.25 BI, n = 137), 1/2 *Bos taurus* - 1/2 *Bos indicus* (.5 BI, n = 96), and full blood Brahman (BI, n = 24) stocker steers and heifers owned by the Texas Agricultural Experiment Station were utilized for this study. A blood sample was taken via tail venipuncture and followed immediately by an intravenous injection of ACTH into the jugular vein. A second blood sample was taken via tail venipuncture 30 min following ACTH injection. There were no differences ($p > .10$) in proportional response of cortisol (PR) between steers and heifers within breedtype. The PR was higher ($p \leq .0028$) in the BT cattle compared to the .50 BI cattle and the BI cattle (2.48 ± 0.20 vs. 1.69 ± 0.15 ; 1.37 ± 0.31 respectively). There was no difference ($p = .31$) in PR between the BT cattle and .25 BI cattle (2.48 ± 0.20 vs. 2.24 ± 0.13 , respectively). The PR was higher ($p \leq .010$) in the .25 BI cattle compared to the .50 BI cattle and BI cattle (2.24 ± 0.13 vs. 1.69 ± 0.15 ; 1.37 ± 0.31 , respectively). The proportional response was not different ($p = .36$) between the .50 BI cattle and the BI cattle (1.69 ± 0.15 vs. 1.37 ± 0.31 , respectively). These results indicate animals of various percentages of *Bos indicus* and *Bos taurus* breedtype respond differently in production of cortisol after exogenous ACTH.

Key Words: *Bos taurus*, *Bos indicus*, cortisol

885 Does pretreatment with GnRH prior to a GnRH-PGF_{2α} (PG) protocol improve synchronization of estrus in beef cattle? F. N. Kojima^{*}, S. L. Wood, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia*.

This experiment was conducted to determine whether addition of GnRH (100 μg Cystorelin[®]) administered 7 d prior to a GnRH-PG protocol (GnRH followed in 7 d with 25 mg PG, Lutalyse[®]) would improve estrous response and/or synchrony of estrus in postpartum suckled beef cows. Primiparous and multiparous Angus crossbred cows were assigned by days postpartum (dpp) to a GnRH-PG (n=29 and n=26, respectively) or GnRH-GnRH-PG protocol (2xGnRH-PG: n=28 and n=26, respectively). Average BCS and dpp for GnRH-PG and 2xGnRH-PG treated cows at the initiation of treatment was 4.6 and 5.2 d, and 4.4 and 5.3 d, respectively. Multiparous cows in the 2xGnRH-PG group had lower ($P < .05$) BCS than contemporaries in the GnRH-PG group (4.2 and 4.7, respectively). Pretreatment cyclicity status did not differ ($P > .10$) between GnRH-PG (62%) and 2xGnRH-PG groups (69%), determined by two blood samples obtained 7 d prior to and on the day treatments were initiated. Cows were observed for signs of behavioral estrus for 7 d following PG, and inseminated 12 h after detected estrus. Synchrony of estrus was analyzed by ratio of variance (F-test) for mean time interval to onset of estrus. Estrous response (75% vs. 80%), synchronized conception rate (76% vs. 67%), synchronized pregnancy rate (56% vs. 54%) and pregnancy rate during the breeding season (87% vs. 89%) did not differ ($P > .10$) between GnRH-PG and 2xGnRH-PG treated cows, respectively. Furthermore, there were no significant differences among these response variables ($P > .10$) between primiparous and multiparous cows. Estrus synchrony among multiparous cows was greater ($P < .01$) for 2xGnRH-PG treated cows (124.2, df=24) than for GnRH-PG treated cows (453.3, df=21), indicated by the lower variance for mean interval to estrus determined by F-test. In summary, the addition of GnRH prior to a GnRH-PG protocol improved synchrony of estrus in multiparous cows with no reduction in fertility.

Key Words: Estrus synchronization, Artificial insemination, Beef cows

886 Estrus and fertility in beef heifers synchronized with melengestrol acetate (MGA) and prostaglandin F_{2α} (PG) with or without GnRH. S. L. Wood^{*}, M. C. Lucy, M. F. Smith, R. F. Randle, D. K. Hardin, and D. J. Patterson, *University of Missouri, Columbia*.

The objective of this field trial was to determine whether addition of GnRH to a MGA-PG estrus synchronization protocol would improve synchrony of estrus and maintain high fertility in beef heifers. Angus beef heifers (n=690) were assigned to one of two treatments by age and reproductive tract score (RTS). Two age groups (older, n=320; younger, n=370) were used in this study. Heifers were fed MGA (.5 mg·hd⁻¹·d⁻¹) for 14 d followed by an injection of PG (25 mg Lutalyse[®]) 19 d after MGA withdrawal (d 33). MGA was delivered in a supplement of 2.25 kg·hd⁻¹·d⁻¹. One-half of the heifers (n=344) received an injection of GnRH (100 μg Cystorelin[®]) 12 d after MGA withdrawal (d 26) and 7 d prior to PG (MGA-GnRH-PG). The control group (n=346) received only MGA-PG. Heifers were monitored for signs of behavioral estrus continuously for 7 d with the Heatwatch[®] Estrus Detection System (DDx, Inc.) beginning on the day PG was administered. Heifers were inseminated 12 h after onset of estrus. Average age, estrous response and conception rates are summarized in the table below. The peak synchronized period was 48-72 h after PG for the older heifers and 36-60 h for the younger heifers. Total and peak estrous response for the older heifers differed between treatments ($P < .05$, $P < .01$, respectively). There were no differences in conception rate between treatments for either age group. These data suggest that addition of GnRH to a 14-19 d MGA-PG estrus synchronization protocol failed to improve total estrous response or synchrony of estrus in replacement beef heifers.

	Older heifers		Younger heifers	
	MGA-PG	MGA-GnRH-PG	MGA-PG	MGA-GnRH-PG
Age (mo)	21	21	15	15
Peak estrus response	126/160 79% ^a	110/160 69% ^b	124/186 67%	116/184 63%
Total estrus response	158/160 99% ^a	148/160 93% ^b	170/186 91%	161/184 88%
1 st service conception	105/159 66%	102/153 67%	109/175 62%	109/166 66%

^{a,b} Values with different superscripts in same row and age group are significantly different ($P < .05$).

Key Words: Heifer, Estrus synchronization, Progesterone

887 Effect of estradiol benzoate (EB) administered at insertion of an intravaginal progesterone releasing insert (CIDR) on pregnancy rates in crossbred *Bos indicus* cows. C. R. Barthle^{*}, J. R. Kempfer, J. K. Fullenwider, J. W. Lemaster, C. L. Barnett, G. E. Portillo, and J. V. Yelich, *University of Florida, Gainesville*.

Crossbred, lactating cows of *Bos indicus* type breeding were used to evaluate pregnancy rates of cows receiving EB or No-EB at CIDR insertion. Cows were randomly assigned to each of six treatments by body condition score (scale 1-9) and postpartum interval at CIDR insertion (d 0 of experiment). All cows received a 7 d CIDR (EAZI-BREEDTM CIDR[®]) and 25 mg of PG (Lutalyse) on d 7. Treatments were: 1) CIDR + 1 mg EB 24 h after CIDR removal and AI 12 h after exhibiting estrus (C); 2) 2 mg EB on d 0 + CIDR + 1 mg EB 24 h after CIDR removal and AI 12 h after exhibiting estrus (EBC); 3) CIDR + 1 mg EB 24 h after CIDR removal and timed-AI (TAI) 48 h after CIDR removal (CTAI); 4) 2 mg EB on d 0 + CIDR + 1 mg EB 24 h after CIDR removal and TAI 48 h after CIDR removal (EBCTAI); 5) CIDR + 100 μg GnRH (Cystorelin) at TAI 48 h after CIDR removal (CGTAI), and 6) 2 mg EB on d 0 + CIDR + 100 μg GnRH at TAI 48 h after CIDR removal (EBCGTAI). Estrus was detected twice daily for 5 d following CIDR removal. Calves remained with cows throughout the experiment. Pregnancy was determined by ultrasonography 50-60 d after AI. Cows receiving EB at CIDR insertion had greater ($P < .05$) conception (56.7 vs 41.2%) and pregnancy rates (53.5 and 37.9%) than No-EB, respectively. Estrous rates were greater ($P < .05$) for the C (92.6%) and CTAI (84.6%) than CGTAI (35.8%) within the No-EB treatments, and were

also greater ($P < .05$) for the EBC (95.7%) and EBCTAI (80.5%) than EBCGTAI (32.9%) within the EB treatments. For No-EB treatments, conception (42.7, 35.9, 38.3%) and pregnancy (39.5, 35.9, 38.3%) rates were similar ($P > .05$) between the C, CTAI and CGTAI, respectively. For EB treatments, conception (59.1, 50.6, 52.9%) and pregnancy (56.5, 50.6, 52.9%) rates were similar ($P > .05$) between the EBC, EBCTAI and EBCGTAI, respectively. EB administered at CIDR insertion increased pregnancy rates in lactating cows of *Bos indicus* type breeding.

Key Words: *Bos indicus*, Estradiol Benzoate, GnRH

888 Effect of estradiol benzoate in combination with progesterone to induce follicular turnover at varying stages of the estrous cycle. V.L. Bogacz^{*1}, J.E. Huston, D.E. Grum, and M.L. Day, ¹The Ohio State University, Columbus.

An experiment was performed to test the efficacy of estradiol benzoate (EB) to induce atresia of the dominant follicle and emergence of a new wave of follicular growth at three stages of the estrous cycle. Thirty-five cyclic beef heifers were observed for estrus twice daily for 30 d. The d of detection of estrus was used to assign heifers to receive treatments at one of three stages of the estrous cycle: early (d 2 to d 6), mid (d 11 to d 13) and late (d 16 to d 21). At the initiation of treatment, (d 0) all heifers received an intra-vaginal progesterone insert (IPI; CIDR-B[®]) for 7 d and 25mg of PGF₂ α at the time of IPI removal. Heifers within each stage were assigned to receive either 1mg EB/500 kg bodyweight (EB; n=13) or no further treatment (0EB; n=14). Ultrasonography was performed daily from d -3 through ovulation. Diameter of the dominant follicle on d 0, was $8.1 \pm .6$ mm, 9.3 ± 1 mm and $14.1 \pm .7$ mm for heifers in the early, mid and late stages respectively with a range of 4 mm to 17 mm. Follicle turnover occurred between d 0 and d 7 in all but one heifer in the late stage that received the 0EB treatment. New wave emergence occurred earlier ($P < .05$) in the 0EB ($2.6 \pm .47$ d) than in the EB (3.9 ± 0.4 d) treatment with no significant treatment by stage interaction. Across treatments, emergence occurred later ($P < .05$) in the early ($4.2 \pm .55$ d) as compared to the late ($2.6 \pm .43$ d) and mid ($2.3 \pm .43$ d) stages. Consequently, diameter of the dominant follicle on d 7 was smaller for heifers in the early ($8.9 \pm .85$ mm) than the late (13.6 ± 1.3 mm) stage. EB treatment tended to reduce ($P = .13$) variation in follicle diameter on d 7 as compared to the 0EB treatment (early $8.2 \pm .9$ vs. 9.7 ± 1.5 ; mid 10.0 ± 0 vs. 11.8 ± 1.2 ; and late $11.8 \pm .48$ vs. 15.5 ± 1.8) respectively. It is concluded that 1mg EB/500 kg bodyweight in conjunction with a progestin induces atresia and new wave emergence and may aid in the standardization of follicle diameter throughout varying stages of the estrous cycle.

Key Words: Estradiol Benzoate, Follicle, Beef Cattle

889 Association of PGF₂ α and estradiol-17 β with function of induced corpora lutea and maintenance of pregnancy in beef cows. P. J. Bridges^{*1}, D. J. Wright¹, W. I. Buford¹, N. Ahmad¹, H. Hernandez-Fonseca¹, M. L. McCormick¹, F. N. Schrick², R. A. Dailey¹, P. E. Lewis¹, and E. K. Inskeep¹, ¹West Virginia University, Morgantown, ²University of Tennessee, Knoxville.

Ability of induced (replacement) corpora lutea (CL) to maintain pregnancy was examined in cows without a primary CL, in which pregnancy had been maintained with exogenous progesterone. In preliminary experiments, more pregnancies were maintained when replacement CL were induced after (13/13), than before (7/14) d 36 of pregnancy ($P < .05$), if CL were adjacent to the gravid horn. An experiment was conducted to directly evaluate the effect of concentrations of PGF₂ α and estradiol-17 β on maintenance of pregnancy by replacement CL. In cows with replacement CL induced before d 36 of pregnancy, that maintained pregnancy while progesterone was provided, maintenance of pregnancy after withdrawal of exogenous progesterone tended to be greater with high (5/5) than low (2/6; $P < .10$) concentrations of PGF₂ α , and low (6/7) than high (2/6; $P = .10$) concentrations of estradiol-17 β between d 31 and 35. In cows with high concentrations of PGF₂ α between d 31 and 35, secretion of progesterone by replacement CL was increased ($P < .05$), but secretion of estradiol-17 β did not differ, compared to cows with low PGF₂ α . Again, maintenance of pregnancy in cows without a primary CL was greater when replacement CL were induced after (9/9) than before d 36 (8/16; $P < .05$). In conclusion, maintenance of pregnancy after induction of replacement CL was increased when CL were induced after d 36 of pregnancy. When a CL was induced before d 36 of pregnancy, concentrations of PGF₂ α affected the ability to form a functional CL.

Higher concentrations of PGF₂ α may increase maintenance of pregnancy in cows via facilitation of embryonic attachment, as has been reported for implantation in other species.

Key Words: Cattle, Embryo Mortality, Corpora Lutea

890 Use of bovine ovarian follicle wall in a culture system to study long-term steroidogenesis. M. Frajblat^{*} and W. R. Butler, Cornell University, Department of Animal Science, Ithaca, NY.

The objective was to develop a long-term culture system for bovine follicle wall that maintains the normal interdependence of theca and granulosa tissues and produces increasing amounts of estradiol (E₂) without supplementation of androgen precursor. Theca and granulosa cells collaborate to produce E₂ and progesterone. Despite the close relationship between these cell types, most research has studied them separately. Ovaries were collected at a slaughterhouse and follicles (<5 mm) were dissected from the ovarian stroma. The follicular wall was peeled away and cut into several pieces for culture in 0.5 ml medium (3 pieces/well). Media was changed every 48 hrs for 6, 8 or 12 days according to the experiment. E₂ secretion increased linearly over 6 days of culture when the media included insulin (10 ng/ml). When IGF-I was also added (50 ng/ml), E₂ secretion was maintained at high levels for 12 days without androgen supplementation. A high E₂:progesterone ratio was also maintained during the 6 or 12 day cultures. Addition of testosterone (at a normal or high concentration, 0.5 and 2.5 μ M, respectively) as substrate for aromatase activity, increased secretion of E₂ significantly ($P < 0.05$). Despite increased E₂ secretion, lactate production was similar ($P > 0.18$) between control and testosterone treatments suggesting that the increase in E₂ was independent of glucose consumption. However, addition of glucose to the culture increased E₂ and lactate production ($P < 0.05$) demonstrating a strong relationship between E₂ secretion and energy availability. All IGF binding-proteins (IGFBP 2,3, 4 and 5) were detected in the culture media despite the high levels of E₂ secretion. When the follicle wall was challenged with 50 or 100 ng/ml of bLH, progesterone secretion increased 4-fold suggesting a shift from estrogen to progesterone synthesis in response to LH. Therefore, in this culture system, the integrity of the follicle wall is maintained and secretion of E₂ increases over a period of 6 to 12 days in culture. This system provides a valuable physiological approach for studying hormonal or metabolic regulation of steroidogenesis in bovine follicles.

Key Words: Follicle, Bovine, Estradiol

891 Development of follicular cysts in cattle is due to an estradiol-induced GnRH/LH surge without subsequent progesterone exposure. A. Gumen^{*}, R. Sartori, F. Costa, and M. C. Wiltbank, University of Wisconsin, Madison.

The hypothesis was tested that follicular cysts are due to lack of a GnRH/LH surge in response to estradiol. We further hypothesized that this condition developed due to estradiol induction of a GnRH/LH surge in the absence of subsequent ovulation. In expt 1, 7 cows were synchronized with an intravaginal progesterone implant (IPI) for 9 d with prostaglandin F₂ α treatment on d 7. All follicles were aspirated at the time of IPI removal using transvaginal follicular aspiration. Two days after aspiration cows were treated with 5 mg estradiol benzoate (EB) to induce a GnRH/LH surge in the absence of an ovulatory follicle. All cows had an LH surge following the estradiol treatment and 3 of 7 developed a large follicle anovulatory condition (LFAC) that resembled follicular cysts. The 4 cows that did not develop LFAC either ovulated or luteinized the cells of the aspirated follicle. Thus, all cows with a progesterone elevation after the estradiol/GnRH/LH surge had subsequent ovulatory cycles; whereas, the absence of progesterone was followed by LFAC. After 49 d the anovulatory cows were induced back to normal cyclicity by insertion of an IPI for 7 d. In two subsequent experiments, 9 of 26 cows were induced to LFAC using follicular aspiration followed by 5 mg EB similar to expt 1. After 26 d of observation all LFAC cows received a second treatment with 5 mg EB and none of the cows showed an LH surge or ovulation in spite of high (>30 pg/ml) serum estradiol concentrations. Cows with LFAC were divided into two groups: untreated (n=4 controls) or treated for 7 d with an IPI (n=5). All cows were subsequently treated for third time with 5 mg EB. All IPI cows had an LH surge in response to estradiol and ovulated; whereas, none of the control cows had an LH surge or ovulation after the estradiol treatment. Thus, LFAC, similar to follicular cysts, can be induced by

estradiol induction of a GnRH/LH surge in the absence of subsequent luteinization. Progesterone eliminates this condition by reinitiation of GnRH/LH surges in response to estradiol.

Key Words: Follicular cysts, progesterone, cattle

892 Differences between lactating cows and nulliparous heifers in follicular dynamics, luteal growth, and serum steroid concentrations. R. Sartori*, J. Haughian, G. J. M. Rosa, R. D. Shaver, and M. C. Wiltbank, *University of Wisconsin, Madison*.

Pregnancy rate per AI is much greater in nulliparous heifers (70%) than in lactating dairy cows (40%). This experiment was designed to compare follicular dynamics, luteal growth, and hormonal patterns in dairy cows with high milk production (C) and nulliparous heifers (H) with similar genetic potential. Holstein cows (n=14; 28 to 100 d postpartum; average milk production >40 Kg/d) and heifers (n=28; 10 to 16 months old) were examined for one normal interovulatory interval using daily ultrasound and blood samples. All the values presented below are expressed in mean±sem. Estrous cycle length was not different (p>.20) between H (23.0±.4 d) and C (23.9±.8 d). Animals in both groups had estrous cycles with 2 follicular waves (13 H and 10 C), 3 waves (11 H and 3 C), or 4 waves (4 H and 1 C). C had greater incidence of multiple ovulations than H (25.0 vs. 1.8%; p<.01). Mean size of ovulatory follicles from C that ovulated 2 or more follicles simultaneously (n=15 follicles) was smaller than the size of ovulatory follicles from H with single ovulation (n=55), which was smaller than the single ovulatory follicles from C (n=21) (13.1±.8; 14.8±.2; and 17.4±.5 mm, respectively; p<.01). Interestingly, serum estradiol near estrus was lower in single ovulating C as compared to H (7.1±.5 vs. 9.4±.6 pg/ml; p<.05) in spite of the larger follicular size in C. Similarly, serum progesterone (analyzed from d 1 to 14 of the cycle) was lower for C than H from d 5 to 14 (on day 14: 4.1±.3 vs. 6.1±.4 ng/ml; p<.01); whereas volume of luteal tissue was greater for C than H (on day 14: 8272±932 vs. 5415±276 mm³; p<.01). Thus, differences between C and H in reproductive parameters, such as multiple ovulation rate and fertility, may be due to lower circulating steroid concentrations in spite of larger follicular and luteal sizes.

Key Words: Fertility, Estrous cycle, Dairy cow

893 The effects of body condition and protein supplementation of postpartum beef cows on estrous behavior and follicle size. C. A. Lents*, F. J. White, D. L. Lalman, and R. P. Wettemann, *Oklahoma Agricultural Experiment Station, Stillwater*.

Multiparous Angus x Hereford cows (n = 45) were fed to calve with a body condition score (BCS; 1 = emaciated, 9 = obese) of thin (< 5) or moderate (≥ 5). Cows were blocked by BCS and calving date (March and April) and randomly assigned to receive either low (1.2 kg/d) or high (2.5 kg/d) amounts of a 42% CP supplement. All cows grazed the same native grass pasture with native grass hay free choice, and were fed supplement in individual stalls for 49.2 ± 2.3 d. Beginning 20 d postpartum, blood samples were collected from each cow three times weekly, and estrous behavior was monitored continuously with the HeatWatch® system. Size of the dominant follicle at 4 to 14 h after the onset of estrus was determined by ultrasonography. Duration of luteal activity (LA) before and after estrus was characterized as short (plasma progesterone ≥ .5 ng/mL for < 5 consecutive samples) or normal (plasma progesterone ≥ .5 ng/mL for ≥ 5 consecutive samples). Body condition score of thin cows was less (P < .01) than moderate cows (4.3 ± .1 vs 5.0 ± .1). Cows on high and low nutrition had similar BCS after treatment (4.5 ± .1). Weight gains tended to be greater for high vs low cows (25 ± 3 vs 17 ± 3 kg; P < .13). Prior to the first estrus, short LA occurred in 65% of cows, normal LA occurred in 27% of cows, and LA was not detected in 8% of cows. First estrus with normal LA was earlier (P < .01) for cows with moderate BCS at calving (64 ± 7 d) compared with thin cows (93 ± 6 d). Duration and number of mounts at the first estrus were not influenced by BCS at calving or postpartum nutrition. Size of the dominant follicle was greater (P < .01) for moderate BCS cows than thin cows (15.3 ± .5 vs 13.4 ± .4 mm), and for high vs low postpartum nutrition (15.0 ± .4 vs 13.7 ± .5 mm). Concentrations of estradiol in plasma at estrus were not influenced by BCS or nutrition. In conclusion, postpartum nutrient intake and BCS at calving influenced the size of the dominant follicle at the first estrus in multiparous beef cows.

Key Words: Nutrition, Estrus, Follicle

894 Effects of urea infusion on uterine luminal pH, prostaglandins and proteins in lactating dairy cows. M. L. Bode*, R. O. Gilbert, and W. R. Butler, *Cornell University, Ithaca, NY*.

Recent studies have demonstrated that decreased fertility in lactating dairy cows is associated with high levels of plasma urea nitrogen (PUN), although the mechanism by which this occurs is unknown. The objective of this study was to monitor changes in the uterine environment during chronic elevation of PUN. Dairy cows (n=8) between 40 to 100 days of lactation were studied on day 7 after estrus. Cows were determined to have ovulated by observation of a corpus luteum (CL) using ultrasonography. Infusion through jugular vein catheters of either saline (n=4) or urea (.01 g urea/hr/kg bwt; n=4) was continued for 24 hrs. Treatments were then switched between groups for a second 24 hr infusion period. Blood samples were collected every 1 to 2 hours to monitor PUN levels. Uterine pH was recorded at 6-hr intervals by inserting a steel cannula containing a micro pH electrode through the cervix and into the uterine lumen. After the termination of each infusion period, 30 ml of sterile saline was flushed into the uterine lumen and immediately retrieved. During urea infusion, the mean PUN level increased from the baseline during saline treatment (16.1 ± 1.5 mg/dl) to that commonly found in high producing dairy cows fed a TMR (23.3 ± 1.0 mg/dl; P=.001). Uterine pH declined during urea infusion from a mean of 7.18 ± .03 at 0 hr to 6.88 ± .03 at 18 hr (P=.06), but remained unchanged in controls (7.16 ± .04 to 7.27 ± .04). PGE₂ and PGF_{2α} levels in uterine lavages were not different between treatments. Proteins in uterine lavage samples were characterized using SDS polyacrylamide gel electrophoresis (SDS-PAGE). Protein profiles appeared to be similar among cows with no obvious differences being observed. Decreases in uterine pH during the infusion periods were correlated with higher plasma progesterone concentrations (P=.04). This study demonstrates that increased PUN can exert direct effects on the uterine environment. However, the mechanism by which changes in the uterine environment may affect fertility in high producing dairy cows needs further study.

Key Words: Cows, pH, Urea

895 Effect of Menhaden fish meal on uterine secretion of PGF_{2α}, dry matter intake, milk yield and milk composition. R. Mattos*¹, J. Williams², C. R. Staples¹, and W. W. Thatcher¹, ¹University of Florida, Gainesville, ²University of California, Davis.

Objective was to determine whether increasing concentrations of dietary Menhaden fish meal (FM) attenuate uterine secretion of PGF_{2α} and alter milk production and composition. Cycling Holstein cows (n=33) averaging 116 d in milk were fed diets containing 0 (Control), 2.6, 5.2 or 7.8% FM (Omega Protein, LA) on a DM basis. Diets were 18.0 to 18.4% CP and 1.67 to 1.69 Mcal NEL/kg. Fish oil was added to the 7.8% FM diet (0.28% of diet DM) to increase intake of PUFA eicosapentaenoic (EPA, C20:5, n-3) and docosahexaenoic (DHA, C22:6, n-3). Average intake of EPA plus DHA were 0, 9.7, 18.3 and 40.1 g/d for cows fed 0, 2.6, 5.2 and 7.8% FM diets. Average DM intake was 25.4, 25.4, 23.8 and 25.1 kg/d (S.E. = 0.9) and milk production was 40.1, 40.7, 35.1, and 40.3 kg/d (S.E. = 2.2). Cows fed the 5.2% diet tended (P = 0.09) to produce less milk. Milk protein concentration increased linearly with increasing intake of FM (b= 0.023 %protein/%FM, P<0.06). Diets did not affect milk fat or milk urea nitrogen concentrations (P > 0.1). At 30 to 34 d after initiation of diets, cows received an injection of GnRH (Cystorelin, Merial, 100 µg) followed by injection of PGF_{2α} after 7 (Lutalyse, Pharmacia & Upjohn, 25 mg i.m.) and 8 d (15 mg i.m.). Injection of hCG (Chorulon, Intervet, 3000 IU) at 24 h after the second PGF_{2α} injection induced a synchronous ovulation in 32 of 33 cows. Subsequent luteal phase concentrations of plasma progesterone did not differ. At 15 d after hCG injection, cows were injected with estradiol-17β (Steraloids, 3 mg i.v.) at 0900 h and oxytocin (100 IU i.v.) at 1300 h. Nineteen blood samples for PGFM analyses were collected from jugular catheters between 1 h before to 4 h after oxytocin injection. Response curves of plasma PGFM concentrations after oxytocin injection were reduced in cows fed FM diets (0% > 2.6, 5.2, 7.8% FM, P < 0.025; 2.6% vs. 5.2% and 7.8% not significant; 5.2% < 7.8% P < 0.05). Thus, increased concentrations of dietary fish meal reduced uterine secretion of PGF_{2α} and increased milk protein concentrations. NRIGCP 98 35203-6367.

Key Words: Fishmeal, Milk, PGFM

896 Characteristics of the reproductive biology of multiparous sows from a commercially relevant population. M.E. Wilson*¹, K.A. Vonnahme¹, G.R. Foxcroft², G. Gourley³, T. Wolff⁴, M. Quirk-Thomas⁵, and S.P. Ford¹, ¹Iowa State University, Ames, ²University of Alberta, Edmonton, ³SGE, Webster City, ⁴Roche Vitamins Inc., Kansas City, ⁵Pig Improvement Company, Frankfort, KY.

A major component limiting litter size is conceptus mortality. In an effort to characterize the timing and pattern of conceptus development and mortality in a commercially relevant pig, we collected mid-pregnant reproductive tracts from 244 PIC Camborough sows representing parities 1 to 14. The animals were slaughtered on d25, 36, or 44 of gestation. Each uterus was trimmed, the length of each horn measured and CL dissected to determine ovulation rate (OR). Conceptuses were removed and fetal weight (FW) and placental weight (PW) were determined. Uterine length (UL) and OR were 434 ± 5 cm and 26.6 ± 4 . Conceptus number decreased ($P < .05$) from 15.8 ± 6 on d25 to 12.9 ± 5 and 12.1 ± 5 on d36 and 44. Conceptus survival to d25 was $60.2 \pm 1\%$ which then decreased ($P < .05$) to $50.1 \pm 1\%$ on d36 and $46.3 \pm 1\%$ on d44. On d25, FW was $.57 \pm .01$ g and increased ($P < .05$) to $4.98 \pm .06$ g on d36 and to $19.2 \pm .17$ g on d44. PW increased ($P < .05$) progressively, averaging $6.1 \pm .2$, 47.2 ± 1.2 and 66.2 ± 1.6 g on d25, 36 and 44, respectively. Placental efficiency (FW/PW) was similar on d25 and 36 ($.12 \pm .01$) and increased ($P < .05$) on d44 to $.33 \pm .01$. There was a positive correlation between conceptus number and OR on d25 ($r = .50$, $P < .05$), but by d36 this association was lost. Conceptus number was not associated with UL on d25; however, by d36 there was a positive association ($r = .36$, $P < .05$) which remained on d44 ($r = .40$, $P < .05$). On all three gestation days there was a negative association between conceptus number and PW ($r = -.33$, $P < .05$), but no association between conceptus number and FW. These data indicate that, compared to commonly reported values, OR in these higher parity production animals is very high and conceptus survival as a result quite low. Additionally, although conceptus number present is related to the OR on d25, by d36 the size of the uterus begins to decrease conceptus survival irrespective of OR.

Key Words: Pig, Litter size, Pregnancy

897 Beta-Lactoglobulin as a modulator of intestinal activity and effects on immunoglobulin uptake in the gut of the neonatal pig. L. F. Sutton*¹ and B. Alston-Mills¹, ¹North Carolina State University, Raleigh.

The effects of the bovine milk whey protein Beta-Lactoglobulin (BLG) on IgG uptake, endogenous porcine production of IgA, IgM, and IgG, proliferation of total intestinal DNA, and intestinal enzymatic activity was investigated. A total of 18 piglets were taken from three sows following parturition and divided into three experimental groups: two removed from the sow immediately (colostrum deprived) and one remained on the sow (control, Treatment 3, $n = 6$). The colostrum deprived piglets were further divided: one receiving commercial bovine colostrum that was supplemented with an extra 10% BLG (Treatment 1, $n = 6$) and the other group receiving only commercial bovine colostrum (Treatment 2, $n = 6$). After 36 hours, all piglets receiving bovine colostrum were placed onto a liquid neonatal diet without additional supplementation. All piglets were weaned at 18 days and placed onto a dry feed diet. Blood samples were collected daily for the first five days and then every three days until day 28 and cast against both porcine and bovine anti-IgA, IgG, and IgM for sera concentrations. Treatment 1 exhibited increased weight gain when compared to the other two groups, and displayed significantly higher concentrations ($p < .001$) of bovine IgG after 3 days. Endogenous production of porcine IgG was found to be highest in controls after 18 days. Levels of endogenous porcine IgG exhibited no differences between treatments after 21 days. Sera levels of IgA and IgM were low amongst all treatments with no treatment effect. Previous results indicate that total DNA concentration was highest in piglets receiving BLG supplementation after 5 days. There was no difference in maltase, lactase, and alkaline phosphatase activity irrespective of treatment. These results suggest that bovine BLG may facilitate uptake of bovine IgG prior to gut closure, have no effect on endogenous production of IgG, IgM, and IgA, and may induce DNA proliferation.

898 Pituitary adenylate cyclase-activating polypeptide induces release of similar amounts of growth hormone before and after meal feeding of steers. R. P. Radcliff*, L. T. Chapin, K. J. Lookingland, and H. A. Tucker, Michigan State University, East Lansing.

Pituitary adenylate cyclase-activating polypeptide (PACAP) induces growth hormone (GH) secretion from cultured bovine pituitary cells. Feeding steers ad libitum for 2 h each day reduces basal secretion of GH for 2 h after feeding. Serotonin (5-HT) induces GH secretion both before and after feeding, but the mediator of 5-HT-induced GH secretion is not known. We hypothesize that PACAP may mediate 5-HT-induced secretion of GH. Initially, five Holstein steers (100 ± 6 kg BW) were used in a 5×5 Latin Square design to determine a dose of PACAP that would induce GH secretion. Each steer was injected i.v. with either 0, 0.1, 0.3, 1, or 3 μg PACAP/kg BW 1 h before feeding on each day. Sampling days were separated by 48 h and each steer eventually received all doses. Blood was collected from jugular catheters at -60, -40, -20, 0, 5, 10, 15, 20, 30, 40, and 60 min relative to injection of PACAP. Compared with controls, 3 $\mu\text{g}/\text{kg}$ BW increased area under the GH response curve (253 ± 40 vs. 407 ± 41 $\text{ng}\cdot\text{ml}^{-1}$ min; $P = 0.04$), as well as peak GH concentrations (10.7 ± 2.0 to 21.5 ± 2.1 ng/ml ; $P = 0.005$), while doses of 0.1, 0.3 and 1 $\mu\text{g}/\text{kg}$ BW were ineffective. Subsequently, we tested if PACAP would induce GH secretion to similar magnitudes before and after feeding as observed with 5-HT. Accordingly, four steers were injected with PACAP (3 $\mu\text{g}/\text{kg}$ BW, i.v.) 1 h before feeding and four were injected 1 h after feeding. Forty-eight hours later treatments were reversed. Blood was collected at -60, -40, -20, 0, 5, 10, 15, 20, 30, 40, and 60 min relative to injection of PACAP. Compared to before feeding, injection of PACAP after feeding induced similar increases in areas under the GH response curve (392 ± 48 vs 275 ± 56 $\text{ng}\cdot\text{ml}^{-1}$ min; $P = 0.16$) as well as peak GH concentrations (19.9 ± 2.3 vs 14.1 ± 2.7 ng/ml ; $P = 0.14$). Therefore, PACAP may mediate 5-HT-induced GH secretion.

Key Words: Pituitary adenylate cyclase-activating polypeptide, Growth hormone, Cattle

899 Pre-weaning growth hormone (GH) response to growth hormone-releasing hormone (GHRH) is indicative of on-test average daily gain (ADG): selection for GH response to GHRH increases its association with ADG. T. L. Auchtung*, S. M. Barao, and G. E. Dahl, University of Maryland, College Park.

Previously we have shown the GH response to GHRH challenge at weaning to be indicative of higher ADG during a standard performance test in Angus bulls and lower on-test ADG in heifers. In this study, we tested the hypothesis that GH response to GHRH would be predictive of ADG at an earlier age. Bulls with the highest and lowest GH responses to GHRH over three years were used as sires, allowing for examination of the persistence of GH response to GHRH through selection. Forty-nine Angus calves (bulls, $n = 24$; heifers, $n = 25$) were challenged with GHRH at 60, 105 and 150 d of age ($SD = 15, 12$ and 14 respectively) and at weaning (219 d; $SD = 25$). Blood samples were taken immediately prior to and 10 min following a clearance dose of 4.5 μg GHRH/100 kg BW and, 2 hr later, immediately prior to and 10 min following a challenge dose of either 1.5 or 4.5 μg GHRH/100 kg BW. Two hours later, the procedure was repeated, with each calf receiving the other challenge dose. All calves in this study were sired by one of four Angus bulls selected for their GH response to GHRH (HI, $n = 2$; LO, $n = 2$). BW was measured every 28 d and ADG was calculated over a 140-d growth performance test (heifers and bulls maintained separately). Response to GHRH was inversely related ($P < .05$) to on-test ADG in heifers of HI sires at 60 d ($R^2 = .30$), 105 d ($R^2 = .22$) and all heifers at 150 d ($R^2 = .08$) and at weaning ($R^2 = .22$). Response to GHRH was positively related ($P < .05$) to on-test ADG in all bulls at 105 d ($R^2 = .28$), 150 d ($R^2 = .27$) and at weaning ($R^2 = .52$). Inclusion of sire in the model improved the correlation between ADG and predicted ADG for both genders. In conclusion, the relationship between ADG and GH response to GHRH is consistent between calves from unselected and selected populations and the relationship is improved with selection. In addition, GH response to GHRH as early as 60 d of age is indicative of on-test ADG in beef cattle.

Key Words: Beef Cattle, Growth Hormone, Predicting Growth

900 Superovulatory responses in cows receiving bovine somatotropin. F. Moreira*, L. Badinga, C. Burnley, and W. W. Thatcher, *University of Florida, Gainesville.*

Objective was to determine effects of bST on early embryonic development in vivo. Lactating (n = 8) and dry (n = 4) Holstein cows were superovulated 2 to 10 times with the following protocol: at experimental d 0, all cows received 2.5 mg of estradiol-17 β and 50 mg of progesterone (i.m.), and two progestin implants (Synchro-Mate-B; 6.0 mg; s.c.). On the afternoon of d 4 and then twice daily until the morning of d 8, cows received a sequence of eight decreasing doses of FSH (Folltropin; 20 mg/ml of NIH FSH-P1; i.m.): two doses each of 4, 3, 2, and 1 ml. On the afternoon of d 6 and morning of d 7, PGF₂ α (Lutalyse; 25 mg; i.m.) was injected. Implants were removed in the afternoon of d 7. After d 8, cows were observed for estrus and received 1 to 4 artificial inseminations (AI) every 12 h while estrus was expressed. At AI, cows were assigned randomly to a non-treated control group (n = 26) or to receive a single injection of bST (n = 26; Posilac; 500 mg; s.c.). Embryos were non-surgically flushed 7 d after AI. Total structures per flush did not differ between bST and control groups (9.3 \pm 1.5 vs 9.4 \pm 1.5), but were greater for dry than for lactating cows (13.3 \pm 2.0 > 5.5 \pm 2.4; P < 0.03). Unfertilized ova per flush was less for bST than for control cows (1.0 \pm 0.9 < 3.7 \pm 0.9; P < 0.04) and less for lactating than for dry cows (0.9 \pm 0.6 < 3.9 \pm 0.5; P < 0.01). Percentage of transferable embryos relative to total structures flushed was greater for bST than for control cows (77.2 % > 56.4 %; P < 0.01). Distribution among stages of development differed between bST and control groups, respectively: morula, 18.4 and 28.0 %; early blastocyst, 41.3 and 53.4 %; blastocyst, 32.5 and 9.3 %; expanded blastocyst, 7.8 and 9.3 % (P < 0.001). Number of blastocysts per flush was greater for bST than for control cows (2.4 \pm 0.7 > 0.4 \pm 0.7; P < 0.04). Administration of bST at AI decreased the number of unfertilized ova, increased the percentage of transferable embryos, and stimulated embryonic development to the blastocyst stage.

Key Words: Bovine somatotropin, Superovulation

901 Effects of melengestrol acetate (MGA) on sexual behavior, testosterone (T) and luteinizing hormone (LH) concentrations in mature beef bulls. D. B. Imwalle, R. D. Smith, A. L. King, J. D. Bailey, and K. K. Schillo, *University of Kentucky, Lexington.*

We investigated the effects of varying doses of MGA on the sexual behavior and concentrations of circulating T and LH in mature Angus bulls. Twenty-four bulls (12-14 mos. of age; 339.06 \pm 6.47 kg body weight) were randomly assigned to four treatment (n=6; 0.0, 0.5, 1.0, 2.0 mg/hd/d) groups. MGA-treated bulls received MGA for 99 days; treatment began on day 0. Plasma was collected sequentially (every 12 minutes for 8 hours) to assess patterns of LH and T on days 18, 9, 37, 65 and 93. Sexual behavior was assessed for 30 minutes on days 13, 15, 43, 71, and 99 with 6 haltered, estradiol-primed, ovariectomized heifers. There were no differences in mounts, LH patterns or T concentrations before treatment (p>.1). Analysis of variance failed to detect a significant treatment by time interaction for LH pulse patterns or mean LH (p>.1) during MGA. Mean LH was lower (p<.05) in controls than in treated animals (0.99 vs. 1.35 ng/ml). Mean LH declined in a linear fashion in all treatment groups (p<.1). Numbers of LH pulses were greater (p<.06) in the 0.5 mg group than in the 1.0 and 2.0 mg groups (2.79 pulses vs. 2.00 pulses/8h). In addition, number of pulses were greater (p<.06) in the 1.0 mg group than the 2.0 mg group (2.46 vs. 1.54 pulses/8h). Analysis of variance revealed a significant treatment by time interaction for T (p<.01) and for mounts (p<.02). Although there were significant differences among treatments at various times there were no consistent dose response relationships between treatment and these traits during MGA. Therefore, it is unlikely that MGA can be used effectively to control sexual behavior in bulls.

Key Words: Sexual Behavior, Bull, MGA

902 Ovulation and synchronization rates in Holstein and crossbred lactating dairy cows during two seasons when receiving the PGF₂ α injection on d 6 or 7 of the Ovsynch protocol. J.L.M. Vasconcelos*, T.P.B. Araujo, R.L.A. Cerri, R.L. Valarelli, and F.S. Wechsler, *FMVZ, Botucatu-Brazil.*

Heat stress inhibits the growth and function of the dominant follicle, increasing the number of cows with three follicular waves. This study

was designed to evaluate whether synchronization rate varied between seasons (winter vs. summer), breeds (Holstein vs. Holstein-Gir) and day of PGF₂ α injection (d 6 or 7 after the first GnRH injection). This trial was conducted in two commercial dairy herds (one with Holsteins and another with crossbred cows) in Brazil, in September, 1999 (winter) and January, 2000 (summer). Cows (n=159) were assigned randomly to receive PGF₂ α injection on d 6 at the acupuncture point BAI HUI, or on d 7 I.M., after the first GnRH injection. Both groups received a second GnRH injection 48h after the PGF₂ α . Ovulation after the first and second GnRH injections and structural regression of the corpus luteum (CL), were evaluated by ultrasonography. Data were analyzed using the logistic regression procedure of SAS. Ovulation rate after the first GnRH injection was higher (P<0.05) in winter than in summer, with 61.4% and 37.8% for Holsteins, and 58.3% and 45.2% for crossbred cows, respectively. The lower ovulation rate during the summer was probably due to rapid loss of ovulatory capacity by the dominant follicle during heat stress. In cows that ovulated following the first GnRH injection (n=81), day of PGF₂ α injection did not influence (P>0.10) CL regression, with 92% for d 6 and 100% for d 7. Summer had more detrimental effect on the synchronization of ovulation of Holstein cows (P=0.07; 62.2 vs. 72.7%) than crossbred cows (59.5 vs. 63.9%). The greater decrease in the synchronization rate of Holstein cows might have been caused by the higher sensitivity to heat stress. Injection of PGF₂ α on d 6 was not efficient in increasing the synchronization rate. Following PGF₂ α injection on day 6, 71.6%, 13.5%, and 14.9% of the cows were synchronized, ovulated between the first and second GnRH injections, or did not ovulate 48h after the second GnRH, respectively; for injection on d 7, the values were 58.8%, 16.5%, and 24.7%, respectively. In conclusion, lactating cows receiving the Ovsynch protocol during the summer suffer a decrease in ovulation and synchronization rates, which may be associated with an increase in the proportion of cows with three follicular waves.

Key Words: synchronization, heat stress, dairy cows

903 Evaluation of injection intervals in a modified ovulation-synchronization protocol in dairy heifers. C. Rose*¹, J. Fuquay¹, A. Moore¹, S. Whisnant², A. Williams¹, S. Willard¹, W. Tucker¹, and P. Ryan¹, ¹Mississippi State University, Mississippi State, ²North Carolina State University, Raleigh.

Our objectives were to: 1) determine the most effective injection intervals for the administration of GnRH and PGF₂ α to induce and synchronize ovulation of the dominant follicle in dairy heifers and, 2) assess the influence of the different injection intervals on subsequent fertility in response to timed-AI. Heifers (n=40) were synchronized on d 0 with a single GnRH injection (Cystorelin, 100 μ g) then divided into two groups. Heifers were treated with PGF₂ α (Lutalyse, 25 mg) either on d 7 or d 12 followed by a second dose of GnRH (100 μ g) 48 h later. All heifers were bred by AI 16 h after the last GnRH injection. Ultrasonography was performed daily on 9 heifers from each group to monitor follicular dynamics and blood was collected from an additional six per group for LH analysis. All heifers had blood collected on Days 3, 6, 12, 21 and 45 post-AI for P₄ analysis. Peak LH concentrations of 15.3 \pm 1.9 and 13.5 \pm 2.2 ng/ml obtained 60 min after GnRH treatment were not different (d 7 vs d 12, respectively). Total LH concentrations were 49.5 \pm 5.2 and 47.0 \pm 7.6 ng/ml, and mean dominant follicle size after the second GnRH injection was 15.1 \pm 1.9 and 17.0 \pm 1.8 mm and did not differ for d 7 and d 12 heifers, respectively. Compared with d 12 heifers, d 7 heifers had higher conception rates (27% vs 7%) and reduced incidence of behavioral estrus (58.8% vs 87.5%) within 18 days post-insemination. Of the d 12 heifers scanned, 4 of 9 had persistent follicles. In addition, serum P₄ concentrations 21 d post-AI were higher (4.8 vs 0.7 ng/ml) for d 12 than for d 7 non-pregnant heifers. These data suggest that extending the interval between the initial GnRH and PGF₂ α injections (12 vs 7 days) failed to reduce the variability in response of dairy heifers to synchronization of ovulation. [Supported by Mississippi Agricultural and Forestry Experiment Station]

Key Words: Dairy heifers, Ovulation-synchronization, Injection intervals

904 Concentrations of progesterone in lactating dairy cows with ovarian follicular cysts. I. Formation of cysts during the early postpartum period. W.J. Silvia*, L.F. Laranja da Fonseca, and S.H. Hayes, *University of Kentucky, Lexington.*

Progestational treatments that maintain concentrations of progesterone at an intermediate level (1 ng/ml) have been shown to inhibit the preovulatory surge of luteinizing hormone (LH) but not the tonic, pulsatile secretion of LH. This results in formation of a persistent follicle that does not ovulate. The objective of this experiment was to determine if an intermediate level of progesterone is associated with the formation of ovarian follicular cysts during the early postpartum period. Twenty-nine lactating Holstein cows were sampled for at least 20 days beginning 9-21 days postpartum. Ovaries were examined three times weekly by transrectal ultrasonography to monitor follicular growth and development. Venous plasma samples were collected daily for quantification of progesterone. Cows were classified into 3 groups based on the development of the first dominant follicle formed. Group 1 consisted of cows in which the follicle ovulated (n=11). Group 2 consisted of cows in which the follicle reached preovulatory size but failed to ovulate and underwent atresia (n=3). Group 3 consisted of cows that formed ovarian follicular cysts (follicle reached preovulatory size, failed to ovulate and persisted for at least 6 days; n=5). The concentrations of progesterone during the 7 days prior to ovulation or attainment of preovulatory size were compared among groups. Concentrations of progesterone were very low (at or below 0.1 ng/ml) in both Groups 1 and 2. In contrast, two of the five cows that formed ovarian follicular cysts (Group 3) had concentrations of progesterone that ranged from 0.1 to 1.0 ng/ml throughout the 7 day period prior to attainment of preovulatory size. The other three cows that formed cysts had concentrations of progesterone that were low and similar to the concentrations observed in Groups 1 and 2. Concentrations of progesterone increased to greater than 0.1 ng/ml in one of these cystic cows 5 days after the cyst was formed. In conclusion, an intermediate concentration of progesterone (0.1 to 1 ng/ml) is sometimes associated with the formation of ovarian follicular cysts but not with normal ovulation or normal turnover of follicles. (supported by the KY Agricultural Experiment Station and KABA/Select Sires)

Key Words: Cyst, Progesterone, Follicle

905 Concentrations of progesterone in lactating dairy cows with ovarian follicular cysts. II. Relationship to subsequent follicular development. T.B. Hatler*, D.W. Yelton, S.H. Hayes, A.M. Nugent, and W.J. Silvia, *University of Kentucky, Lexington.*

The first objective of this experiment was to determine the peripheral concentration of progesterone (P) in cows diagnosed with ovarian follicular cysts. Nonpregnant, lactating Holstein and Jersey cows were palpated per rectum at 10-day intervals as part of routine reproduction management. Cows suspected of having ovarian cysts were examined by transrectal ultrasonography for verification (follicle diameter > 20 mm, no luteal tissue). Following verification, cows (n=32) were examined by transrectal ultrasonography three times weekly and venous blood samples were collected daily for quantification of P. Concentrations of P at the onset of sampling were classified as low (<0.1 ng/ml), intermediate (0.1 to 1.0 ng/ml) or high (1.0 to 2.0 ng/ml). The percentages of cows with low, intermediate and high concentrations of P were 25%, 66% and 9%, respectively. Thus, 75% of follicular cysts are associated with intermediate or high concentrations of P. The second objective of this experiment was to determine the fate of follicles that reached preovulatory size (20 mm) in the presence of ovarian follicular cysts and to relate that to concentrations of P. Follicles were classified, retrospectively, as either ovulating (n=21) or failing to ovulate (n=36; either forming a cyst (persistent for at least 6 days; n=31) or undergoing normal follicular turnover (n=5)). Concentrations of P during the 7-day period prior to ovulation or attainment of preovulatory size were examined. Follicles that ovulated were associated with either of two patterns of P during the period. Some cows (n=13) had intermediate or high concentrations of P initially, then declined to 0.1 ng/ml or below for at least 1 sample prior to ovulation. Other cows (n=8) were low throughout. Follicles that failed to ovulate were associated with either of two patterns. Some (n=20 follicles observed in 11 cows) had intermediate or high concentrations of P throughout the 7 day period prior to attainment of preovulatory size. Others (n=17 follicles observed in 3 cows) had low

concentrations of P throughout. Thus, intermediate or high concentrations of P were frequently associated with ovulation failure. (supported by the KY Agricultural Experiment Station and KABA/Select Sires)

Key Words: Cyst, Progesterone, Follicle

906 Effect of ergotamine on plasma metabolite concentrations in norgestomet-treated cows. R. Browning, Jr.*, *Tennessee State University, Nashville.*

The influence of ergotamine, a tall fescue ergopeptine alkaloid, on metabolic intermediates was assessed in six cycling Holstein F₁ cows (31 to 33 mo of age). On two occasions, paired cows were injected i.m. with 25 mg of PGF_{2α} and treated with a s.c. ear implant containing 6 mg of norgestomet. Ten day after implant insertion, plasma was sampled every 20 min for 1 h before an i.v. bolus of ergotamine tartrate (20 µg/kg body weight; ET) or saline vehicle (SV) and for 7 h after treatment. Mean ambient temperature was 31.6°C (SD = 2.2) and relative humidity averaged 50.1% (SD = 14.6) during data collection. Each heifer received one treatment per synchronized period and both treatments during the study; 6 wk separated the estrous synchronization periods. Treatment x time affected (P < .001) plasma concentrations of glucose, triglyceride, and total cholesterol and tended (P = .09) to influence urea nitrogen. All means were separated by protected LSD procedure at an alpha level of 1%. Glucose increased from 71.7 ± 3.1 mg/dL before ET to 107.3 ± 6 mg/dL 2 h after ET, but was unchanged after SV. Triglyceride increased from 27.3 ± .8 mg/dL before ET to 35.5 ± .9 mg/dL 1 h after ET, then declined to 16.3 ± .5 mg/dL by 7 h after ET, but was unchanged after SV. Total cholesterol for ET cows continuously increased from 114.9 ± 1.7 mg/dL before treatment to 122.6 and 134.9 ± 1.9 mg/dL by 2 and 6 h, respectively, after treatment. Plasma cholesterol increased gradually in SV cows from 113.4 ± 1.7 mg/dL before treatment to 121.7 ± 1.9 mg/dL by 6 h after treatment. From 2 to 7 h post-treatment, ET cows had higher (P < .001) total cholesterol concentrations than SV cows. Urea nitrogen increased from 10.7 ± .2 mg/dL before ET to 11.5 ± .2 mg/dL from 4 to 7 h after ET, but was unchanged after SV. Results indicate that ergotamine can alter plasma concentrations of intermediates that are involved in nutrient metabolism of cattle.

Key Words: Cows, Ergotamine, Metabolites

907 Evaluation of pregnancy rates in lactating dairy cows using two systematic breeding protocols for first and second service. B. G. Dransfield, R. L. Nebel*, J. H. Bame, and D. A. Henderson, *Virginia Polytechnic Institute and State University, Blacksburg.*

Six hundred and nine Holstein cows from 19 commercial dairy herds were used to evaluate pregnancy rates obtained following two systematic breeding protocols. Cows were assigned randomly at each location to either timed AI (TAI) consisting of 25 mg of PGF_{2α} (d -23) followed by 100 µg GnRH (d -9) then 25 mg of PGF_{2α} (d -2) and 100 µg GnRH (d 0) with AI 6 to 18 h later or Modified Targeted Breeding (MTB) that eliminated the second GnRH administration on d 0 and included periodic visual observation and AI following the detection of estrus or timed AI at 72 to 80 h if estrus was not detected. Initial PGF_{2α} administration occurred at approximately 45 DIM. If a cow was determined not to be pregnant during bi-monthly uterine palpation the initial protocol was repeated eliminating the first PGF_{2α} administration. There was no detectable difference in days to first AI for TAI (71.9 d) and MTB (73 d). First service pregnancy rates for TAI and MTB protocols differed across herds with a mean of 25.9% for MTB and 30.8% for TAI with a herd X protocol interaction (P < 0.05). Pregnancy rates for the MTB protocol increased if cows were detected in estrus (50%) versus cows bred on appointment (15.5%). Second service pregnancy rates improved for both protocols to 34.6% for MTB and 38.7% for TAI. Month of AI did influence pregnancy rates for both first and second service (P < 0.01). Pregnancy rates were highest for MTB in herds that had excellent estrus detection. However, TAI had an overall higher pregnancy rate with the elimination of estrus detection.

Month	Pregnancy rate first service (%)	
	MTB	TAI
May	27.3	37.9
June	30.4	36.8
July	21.2	15.6
August	22.2	27.8
September	32.7	30.2
October	18.5	42.9

Key Words: Systematic breeding, Dairy cattle, Pregnancy rates

908 Comparison of modified target breeding and presynch-timed artificial insemination at first insemination postpartum. E. Jordan^{*1}, M. Schouten², J. Quast³, A. Belschner⁴, and M. Tomaszewski¹, ¹Texas A&M University, College Station, ²Hico, TX, ³Comanche, TX, ⁴Pharmacia & Upjohn, Kalamazoo, MI.

A field trial was conducted on a large Central Texas dairy to evaluate the effectiveness of two synchronization regimes on first service pregnancy rate. For 11 months cows were grouped based on week of calving and assigned to one of two synchronized insemination groups. Cows on both groups received an injection of PGF_{2α} 21 ± 3 days prior to the conclusion of the 60 day voluntary waiting period, followed by GnRH 14 days later and a second PGF_{2α} injection 7 days after the GnRH injection. During the two days following the second PGF_{2α} injection, cows in the Modified Target Breeding (MTB) treatment were inseminated based on signs of estrus. Any cow not inseminated by 72 hours after the second PGF_{2α} injection was inseminated at 72 hours. In the Presynch-Timed Artificial Insemination (Pre-TAI) treatment, cows were given a second GnRH injection 48 hours after the second PGF_{2α} injection and were inseminated 24 hours later. Injections, inseminations and estrous detection occurred in the morning throughout the trial, due to the potential impact of heat stress during the summer and for labor management reasons. During the trial 566 cows were assigned to MTB and 486 cows to Pre-TAI. Lactation number, purchased or raised, calving ease score, multiple births, abortions, gender of calf, retained placentas, mastitis prior to 70 DIM, whether the technician defined the cow in estrus at insemination (Estrus-B), number of estruses detected prior to insemination, season of calving, season of insemination, days dry, and previous gestation length were recorded. One hundred percent of the cows were inseminated in both treatments. The GENMOD Procedure in SAS was used to analyze the data. The first service pregnancy rate was 30.9% and 28.6% for MTB and Pre-TAI, respectively. Treatment group, Estrus-B, season, multiple births, retained placenta and mastitis prior to 70 DIM significantly ($p < .05$) impacted conception. Initiating a lactation with an abortion, calving ease score, lactation number, purchased or raised and the gender of the calf were not significant. Treatment X Estrus-B was the only significant interaction ($p < .01$).

Key Words: Modified Target Breeding, Estrous Synchronization, Pregnancy Rate

909 Evaluation of two timed artificial insemination (TAI) protocols for reproductive management of lactating dairy cows in grazing-based dairy systems. M. C. Cordoba^{*} and P. M. Fricke, *University of Wisconsin, Madison.*

Lactating dairy cows (n=165) from two grazing-based dairies were randomly but unequally assigned to one of three groups to receive either Ovsynch (50 µg GnRH, Day -10; 25 mg PGF_{2α}, Day -3; 50 µg GnRH, Day -1) and TAI on Day 0 (Group 1), a modified Ovsynch and TAI similar to Group 1 but with the addition of 25 mg PGF_{2α} 12 d before initiation of Ovsynch (Day -22; Group 2), or standard reproductive management (natural service and/or AI at estrus beginning on Day 0; Control). Ovulatory response at 48 h after the second GnRH injection (synchronization rate), conception rate after TAI at Day 32, and cumulative pregnancy rate at Day 32 and 60 was determined using transrectal ultrasound. Blood samples collected on Day -22, -21, and -11 were classified based on serum progesterone (P) concentrations as High (≥1 ng/ml) or Low (<1 ng/ml). Luteolysis (High P on Day -22, Low P on Day -21) was greater ($p < 0.01$) for cows in Group 2 (86.4%; 19/22) compared with Group 1 (0%; 0/18). Synchronization rate (84.2%, 48/57 vs. 78.3%, 47/60), conception rate at Day 32 (43.4%, 23/53 vs. 41.0%, 25/61) and pregnancy rate at Day 60 (57.1%; 32/56 vs. 51.7% 30/58) was similar for cows in Group 1 and 2, respectively. The proportion of anestrous cows (Low P on Day -22 and -11) was similar for Group 1 (28.8%, 15/52) and

2 (26.7%, 16/60), and conception rate at Day 32 was similar ($p = 0.19$) for cycling (45.6%, 36/79) and anestrous (33.3%, 10/30) cows receiving TAI. Cumulative pregnancy rate was greater ($p < 0.01$) for cows receiving TAI (42.1%, 48/114) compared with Control cows (15.2%, 7/46) at Day 32 but did not differ at Day 60 (54.4%, 62/114 vs. 62.2%, 28/45 for TAI vs. Control, respectively). Synchronization of ovulation to initiate TAI at the onset of the breeding season resulted in earlier establishment of pregnancy compared with standard reproductive management. Administration of PGF_{2α} 12 d before initiation of Ovsynch did not improve synchronization, conception, or pregnancy rate compared with Ovsynch. *Supported by Hatch project WIS04222*

Key Words: Ovsynch, Timed AI, Grazing

910 Use of estradiol cypionate for timed insemination. F.L. Lopes^{*}, D.R. Arnold, J. Williams, S.M. Pancarci, M.J. Thatcher, M. Drost, and W.W. Thatcher, *University of Florida, Gainesville.*

Four experiments (Exp) evaluated use of estradiol (E₂) cypionate (ECP) for timed insemination in dairy cattle. All animals were synchronized with injection of GnRH (100 µg) on d 0, feeding melengestrol acetate (MGA) on d 1 - 6 (0.5 mg/d) and injection of PGF_{2α} on d 7. Exp 1 examined plasma E₂ concentrations and ovulation after injection of 0 (n = 7), 0.5 (n = 7), 1 (n = 8) or 2 (n = 7) mg ECP on d 8. Blood was collected twice daily and ovulation time determined by ultrasound. Peak concentrations of E₂ occurred 1 - 1.5 d after ECP and differed between groups (12 pg/ml, 0 mg ECP < 25 pg/ml, 0.5 and 1.0 mg ECP < 35 pg/ml, 2 mg ECP; $P < 0.01$). Concentrations of E₂ differed at 4 d after ovulation (4 pg/ml, 0 ECP < 7 pg/ml, 0.5 and 1.0 mg ECP < 12 pg/ml, 2 mg ECP; $P < 0.01$). Ovulation time was shorter and better synchronized for 0.5 and 1 mg ECP than for 0 and 2 mg ECP groups (63 ± 5, 60 ± 2 versus 83 ± 13, 81 ± 6 h; $P < 0.01$). In Exp 2, plasma LH was characterized after ECP (1 mg, n = 6; 24 h after PGF_{2α}) versus GnRH (100 µg, n = 6; 48 h after PGF_{2α}). Blood was collected every 2 h for 50 h (ECP) or at 15 - 30 min intervals from -1 to 6 h (GnRH). After ovulation, cows were bled daily until next ovulation, and first wave follicular dynamics examined at 1, 3, 5, 7 d. ECP treated cows had a longer LH surge (10 h > 4 h; $P < 0.01$) and no differences were detected in plasma progesterone or follicular dynamics. In Exp 3, ovulation in 14 heifers treated with 0.5 mg of ECP occurred at 62 ± 2 h after ECP. In Exp 4, heifers (n = 158) were assigned to control or ECP timed insemination groups in August. Following synchronization (GnRH, MGA, PGF_{2α}), control heifers were inseminated at estrus, and ECP treated heifers were injected with 0.5 mg ECP on d 8 and timed inseminated 48 h later. Pregnancy rates (PR) did not differ between control (39.2%) and ECP treated (39.2%) heifers. In conclusion, ECP in multiparous dry cows (1 mg) and heifers (0.5 mg) was effective to induce a LH surge, a synchronized ovulation with a subsequent normal luteal phase, and normal PR in heifers.

Key Words: Timed Insemination

911 Stage of cycle, incidence and timing of ovulation, and pregnancy rates in dairy cattle after three timed breeding protocols. J.A. Cartmill^{*1}, S.Z. El-Zarkouny¹, B.A. Hensley¹, G.C. Lamb², and J.S. Stevenson¹, ¹Kansas State University, Manhattan, ²University of Minnesota, Grand Rapids.

In Exp. 1, estrous cycles in dairy cows (n = 705) were synchronized prior to timed AI. The first treatment (PGF_{2α}+OVS) consisted of one injection of PGF_{2α} given 12 d (d -22) before initiating the Ovsynch (OVS) protocol (GnRH given 7 d before [d -10] and 48 h [d -1] after PGF_{2α} [d -3]) with the object to increase the percentage of cows in their early luteal phase before the onset of the OVS protocol (d -10). We compared the latter two protocols to a third protocol in which cows were given two injections of PGF_{2α} 12 d apart (2×PG12; d -15 and -3), followed 48 h later by an injection of GnRH (d -1). In all three protocols, one timed insemination (d 0) was made 16 to 20 h after the single or second injection of GnRH (d -1). Blood was collected on d -22, -15, -10, -3, and -1 before hormone or placebo injections and assayed for progesterone. More ($P < 0.05$) cows treated in the PGF_{2α}+OVS (36%) or 2×PG12 (29%) protocols were in their early luteal phase (d 5 to 9) at the onset of the OVS protocol than cows in the OVS protocol (18%). Cows in their first lactation had greater ($P < 0.01$) pregnancy rates 28 d after insemination than cows in their second or greater (L2+) lactation (41 vs. 32%). Cows (L2+) had greater ($P = 0.08$) pregnancy

rates in the PGF_{2α}+OVS (42%) treatment than their contemporaries in the OVS (28%) and 2×PG12 (27%) treatments. Embryo survival (67 to 74%) between d 28 and d 38-58 of pregnancy depended on cycling status of cows before treatment. In Exp. 2, follicle diameter in a sub-group of cows from each treatment was determined via ultrasonography prior to GnRH injection (48 h after PGF_{2α}) and between 32 and 48 h after GnRH or until ovulation occurred. Mean preovulatory follicle diameters were larger (P < 0.05) in 27 spontaneously ovulating controls and in the 2×PG12 cows and less (P < 0.05) variable in diameter in controls than in all treated cows. More (P < 0.05) control cows (93%) ovulated by 32 h than cows in the OVS (55%), PG+OVS (64%), and 2×PG12 (56%) treatments. We concluded that a presynchronizing injection of PGF_{2α} given 12 d before OVS increased pregnancy rates in older cows.

Key Words: Timed AI, Ovulation synchronization, Embryonic survival

912 Reproductive characteristics of dairy cows following early nonpregnant diagnosis by ultrasonography on days 27 to 29 after AI and subsequent treatments with PGF_{2α} and(or) GnRH. J.S. Stevenson*, J.A. Cartmill, B.A. Hensley, and S.Z. El-Zarkouny, *Kansas State University, Manhattan.*

Our objective was to determine the feasibility of prompt reinsemination of dairy cows once diagnosed not pregnant 27 to 29 d after AI when a first-wave dominant follicle was present that could ovulate after precocious luteal regression occurred in response to PGF_{2α}. Cows diagnosed not pregnant by ultrasonography on either 27, 28, or 29 d after AI (corresponding to d 6, 7, or 8 of the estrous cycle for cows not detected in estrus after first insemination [assuming a 21-d estrous cycle]) were treated with 25 mg of PGF_{2α}. Approximately half of the cows were then treated with 100 μg of GnRH 48 h later and inseminated 16 to 20 h after GnRH (PG+GnRH; n = 147). Cows treated only with PGF_{2α} were inseminated 8 to 16 h after detected estrus (PG; n = 120). For comparisons of reproductive characteristics, 390 control cows were reinseminated after nonpregnant diagnosis based on detection of natural estrus ±14 d of reinsemination dates of treated cows. Blood samples were collected at the time of pregnancy diagnosis in nearly all cows and again 48 h later in fewer cows. Treated cows (30 ± 1 d) were re-inseminated earlier (P < 0.05) after last AI than controls (40 ± 2 d) but conception rates were not different: 27.4, 25.0, and 24.5% in control, PG, and PG+GnRH cows, respectively. Open cows treated 27 d after AI (85 ± 6) had more (P < 0.05) days from treatment to conception than cows treated on d 28 or 29 (58 ± 10). More (P < 0.05) control than treated cows (61 vs. 19%) were eventually culled from the herds. Just over 70% of the cows had elevated (≥1 ng/mL) concentrations of progesterone before treatment and 80% of cows given PGF_{2α} were synchronized based on decreased concentrations of progesterone by 48 h after PGF_{2α}. We conclude that treating nonpregnant cows with PGF_{2α}, GnRH, or both on d 27 to 29 after insemination produced conception rates equal to that of controls. Cows treated on d 28 or 29 conceived earlier than those treated on d 27 probably due to poorer rates of PGF_{2α}-induced luteolysis on d 27.

Key Words: Early Pregnancy Diagnosis, Resynchronization, GnRH

913 Progesterone increases pregnancy rates and embryo survival in lactating dairy cows. S.Z. El-Zarkouny*, J.A. Cartmill, B.A. Hensley, and J.S. Stevenson, *Kansas State University, Manhattan.*

Our objective was to investigate the effect of progesterone (P4) on pregnancy rates and embryo survival in cows treated with P4 concurrent with the Ovsynch protocol. Lactating Holstein cows were assigned randomly to three treatments: 1) Ovsynch (OVS; n=91; GnRH given 7 d before [d -10] and 48 h [d -1] after PGF_{2α} [d -3]); 2) OVS+CIDR (n=90; same as OVS with an intravaginal CIDR insert containing 1.9 g of P4 in situ for 7 d [d -10 to -3]); and 3) control (n=80). Controls received no treatment but had HeatWatch® patches attached to their rumps containing pressure-sensitive radiotelemetric transmitters to enable detection of estrus. Cows in the first two treatments were inseminated 17 to 19 h after the second GnRH injection (d 0), whereas controls were inseminated 8 to 16 h after detected estrus. Blood samples were collected on d -20 and prior to each hormone treatment (d -10, -3, and -1) for determination of P4. Pregnancy status was verified on d 28 and 56 after AI by ultrasonography of uterine contents and by palpation once between 40 and 53 d. Concentrations of P4 on d -20 and -10 revealed that only 44.4% of the cows had at least one elevated (≥1 ng/mL) P4 sample and were considered to be cycling. Only 58, 67, and 36% of the OVS+CIDR, OVS,

and controls had elevated concentrations of P4 at the time of PGF_{2α} injection. Diameter of the preovulatory follicle was greater (P < 0.05) on d -1 in older cows treated with the CIDR (17.4 ± .6 mm) than in older cows (15 ± .6 mm) in the OVS protocol, whereas no differences were detected among first-lactation cows. Over 80% of the treated cows ovulated by 48 h after GnRH. Pregnancy rates on d 28 (58 vs. 36%) and d 56 (44 vs. 20%) were greater (P < 0.05) in the OVS+CIDR than in the OVS cows, respectively, indicating greater (P < 0.05) embryo survival (75.6%) due to P4 treatment than in OVS alone (56.1%). At palpation, pregnancy rates were 25% in controls, 39% in OVS+CIDR, and 21% in OVS cows. We concluded that P4 treatment in conjunction with the OVS protocol improved pregnancy rates in high-producing dairy cows despite <50% of the cows cycling at the onset of treatments.

Key Words: Progesterone, Pregnancy Rate, Ovsynch Protocol

914 An estrous synchronization field study comparing estradiol benzoate (EB) and GnRH in combination with an intravaginal progesterone insert (CIDR) for timed-AI in crossbred *Bos indicus* cows. J. K. Fullenwider, J. R. Kempfer, C. L. Barnett, G. E. Portillo, C. R. Barthle, and J. V. Yelich*, *University of Florida.*

Two estrous synchronization experiments were conducted in crossbred *Bos indicus* cows to compare pregnancy rates of two timed-AI protocols. In both experiments, cows were body condition scored (BCS; scale 1-9) and received 2 mg of EB on d 0 of a 7 d CIDR (EAZI-BREED™ CIDR®) and 25 mg of PG on d 7. Cows were randomly allotted to one of two treatments: 1) 1 mg EB 24h after CIDR removal (CEB) and 2) 100 μg GnRH (Cystorelin) at AI (CGnRH). All cows were AI 48-54 h after CIDR removal. Semen from multiple sires were equally allotted to each treatment and randomly assigned within a treatment. Pregnancy was determined by ultrasonography 50-60 d after AI. In experiment 1, dry cows at four locations were used. Pregnancy rates were similar between CEB (126/267 = 47.2%) and CGnRH (131/281 = 46.6%) and not affected (P > .10) by location, BCS or technician. Pregnancy rates were influenced by sire (P < .001) but there was no sire by treatment (P > .10) effect. Sire pregnancy rates were: A) 14/56 = 25.0%; B) 18/56 = 32.1%; C) 22/51 = 43.1%; D) 25/58 = 43.1%; E) 20/46 = 43.5%; F) 27/55 = 49.1%; G) 28/55 = 50.9%; H) 34/59 = 57.6%; I) 31/52 = 59.6%; J) 35/57 = 61.4%. In experiment 2, 387 postpartum-lactating cows were used with 48 h calf removal initiated on d 7. Cows were managed in two age groups, ≤ 3 (BCS = 4.3; n = 125) and ≥ 4 (BCS = 5.0; n = 262). Overall, pregnancy rates were greater (P < .05) for CEB (54.0%) than CGnRH (43.9%). Pregnancy rates tended (P < .06) to be influenced by sire and there was a treatment by sire effect (P < .01). Pregnancy rates were greater (P < .05) in the ≥ 4 age group for CEB (61.4%) than CGnRH (46.6%) but similar (P > .05) in the ≤ 3 age group (P > .05) for CEB (40.0%) than CGnRH (38.3%). In conclusion, timed-AI protocols were effective in lactating and dry crossbred *Bos indicus* cows although effectiveness may be limited by semen fertility.

Key Words: *Bos indicus*, Estradiol Benzoate, GnRH

915 Effect of dosage of gonadotropin-releasing hormone (GnRH) in an estrus synchronization protocol on conception rates to a fixed-time insemination in postpartum beef cows. D.L. Funk* and L.H. Anderson, *University of Kentucky, Lexington.*

A major limitation to the implementation of estrus synchronization systems which include GnRH is the high expense of GnRH. Previous research has suggested that 50 μg of GnRH will induce ovulation of a dominant follicle as effectively as 100 μg in yearling dairy heifers. The objective of this experiment was to determine whether decreasing the dosage of GnRH from 100 to 50 μg in the CO-Synch estrus synchronization protocol would alter pregnancy rates to a fixed-time insemination in postpartum beef cows. Postpartum cows (n = 494) at 5 locations were randomly assigned by calving date and age to receive either 50 or 100 μg of GnRH on D 0. Because a percentage of postpartum cows will show estrus on D 6 or 7, cows were observed for estrus on these days. Cows showing estrus on D 6 or 7 were inseminated 12 hours after observed estrus and received no further treatment. On D 7, to regress both the initial and any accessory corpus luteum, the remaining cows received 25 mg of prostaglandin F_{2α} (Lutalyse; Pharmacia & UpJohn, Kalamazoo, MI). On D 9, cows were administered a second injection of the same dose of GnRH and artificially inseminated. Beginning on D 23, all cows

were exposed to a 45-day natural breeding season. Date of conception was estimated using transrectal ultrasonography on approximately D 90. Conception rates to the fixed-time insemination were significantly lower ($P < .05$) for cows receiving 50 μg GnRH (32%; 76/239) than those cows receiving 100 μg GnRH (42%; 106/255). Although treatments varied by location ($P < .05$), no treatment by location interaction was observed ($P > .10$). We conclude that 50 μg GnRH is likely inadequate to synchronize estrus and ovulation and therefore reduces the conception rates of postpartum beef cows to a fixed-time insemination.

Key Words: GnRH, Estrus Synchronization, Cattle

916 Addition of GnRH or an intravaginal progesterone insert to a GnRH-PGF synchronization system to enhance response to timed breeding in postpartum beef cows. S.K. Johnson^{*1}, D.E. Grum², and M.L. Day², ¹*Kansas State University, Colby*, ²*The Ohio State University, Columbus*.

The objective of this study was to determine if the responsiveness of postpartum (pp) beef cows to a GnRH-PGF synchronization system for timed AI could be improved by addition of a progestin or an additional injection of GnRH. Postpartum beef cows ($n=1035$) from two herds (10 groups) were assigned by calving date and age to one of four treatments. All cows received an injection of PGF_{2 α} (25 mg, i.m.) on d 0 and GnRH (100 μg , i.m.) on d 2 at timed insemination. Treatments were as follows: 1) GnRH on d -7 (GnRH-PGF); 2) GnRH on d -14 and d -7 (+GnRH); 3) GnRH on d -7 and an intravaginal progesterone insert (CIDR) from d -7 to 0 (GnRH/CIDR); 4) CIDR from d -7 to 0 (CIDR). On d 0, cows averaged 71 d pp. Pregnancy was diagnosed by transrectal ultrasound between 75 and 50 d following timed AI. Cow age, service sire, AI technician and the treatment by location interaction were not significant for any of the variables tested and were removed from the statistical analyses. Pregnancy rate to timed AI was lower ($P < .05$) in CIDR (39%) compared to GnRH-PGF (47%). Pregnancy rates in +GnRH (50%) and GnRH/CIDR (45%) were not different from GnRH-PGF. Cows less than 60 d pp on d 0 had a lower ($P < .05$) pregnancy rate (39%) compared to cows 60-80 d pp (50%) or cows > 80 d pp (47%). For cows < 60 d pp ($n=297$), pregnancy rate was lower ($P < .05$) for GnRH-PGF cows compared to +GnRH (36% vs 53%, respectively) and did not differ from GnRH/CIDR and CIDR. Ovarian status (cyclic vs anestrous) prior to the start of treatments (determined in fifty 2-yr-old cows and 98 later calving cows in one herd) did not influence response to treatments. An additional injection of GnRH one week prior to the GnRH-PGF treatment improved pregnancy rates to timed AI in cows less than 60 d pp at breeding. The addition of a CIDR to the GnRH-PGF system did not influence pregnancy rates, whereas removal of the initial injection of GnRH on d -7 reduced pregnancy rates in the timed AI program evaluated.

Key Words: Timed insemination, GnRH, Progestin

917 Effect of an orally active progestin on follicular dynamics in cycling and anestrous postpartum beef cows. G. A. Perry^{*1}, F. N. Kojima¹, B. E. Salfen¹, J. F. Bader¹, D. J. Patterson¹, and M. F. Smith¹, ¹*Department of Animal Science, University of Missouri, Columbia*.

Melengestrol acetate (MGA) is an orally active progestin that is widely used for synchronizing estrus in beef cattle. Although treatment of cycling cows with low concentrations of a progestin (i.e. MGA) results in formation of persistent follicles in the absence of corpora lutea, it is not known whether persistent follicles form in anestrous cows in response to a similar treatment. The objective of this experiment was to determine the effect of MGA on follicular dynamics in anestrous postpartum beef cows. Treatment groups included the following: anestrous control (AC), anestrous MGA (AM), and cycling MGA (CM; positive control). Angus-crossbred cows were assigned to treatment by age and days postpartum. Cows were fed carrier (AC group) or 0.5 mg MGA $\cdot\text{hd}^{-1}\cdot\text{d}^{-1}$ (AM and CM groups) for 14 d beginning approximately 38 d postpartum. Cows allotted to the CM group were injected with PGF_{2 α} on the first day of MGA treatment to induce luteolysis. The preceding treatment (CM) results in formation of persistent follicles and secretion of elevated concentrations of estradiol. Ovaries of each cow were examined daily by transrectal ultrasonography beginning 5 d preceding the initiation of feeding MGA or carrier until ovulation or 7 d following MGA feeding. There was no difference among groups in the stage of follicular wave or diameter of the largest follicle at the start of carrier or MGA

feeding. The length of the follicular wave present at the start of MGA was greater ($P < .02$) for cows in the CM (14.5 d) group compared to the AM (9.4 d) or AC (9.7 d) groups. Maximum follicular diameter was greater ($P < .02$) for the CM (18.9 mm) group than the AM (15.8 mm) or AC (16.0 mm) groups. Circulating concentrations of estradiol were also increased ($P < .05$) in the CM group compared to the AM or AC groups. In summary, MGA treatment did not increase the duration of the follicular wave, maximum follicular diameter, or secretion of estradiol in anestrous postpartum cows.

Key Words: Progestin, Follicle, Beef Cows

918 Inclusion of an intravaginal progesterone insert plus GnRH and prostaglandin F_{2 α} for ovulation control in postpartum suckled beef cows. G. C. Lamb^{*1}, J. S. Stevenson², D. J. Kesler³, H. A. Garverick⁴, D. R. Brown¹, and B. E. Salfen⁴, ¹*North Central Research and Outreach Center, University of Minnesota, Grand Rapids*, ²*Department of Animal Sciences and Industry, Kansas State University, Manhattan*, ³*Department of Animal Sciences, University of Illinois, Urbana*, ⁴*Department of Animal Sciences, University of Missouri, Columbia*.

Four experiment stations (IL, KS, MN, and MO) conducted an experiment to determine the effects of introducing an intravaginal progesterone insert (IPI; CIDR-B, InterAg, Hamilton, NZ) into a synchronization system for postpartum suckled beef cows. Five hundred and forty-four cows were assigned randomly to two synchronization treatments: 1) 100 μg of GnRH (i.m.) followed in 7 d with 25 mg of PGF_{2 α} , followed by a second injection of GnRH and one fixed time insemination (Cosynch; $n = 279$); or 2) Cosynch plus one IPI during the 7 d between the first injection of GnRH and PGF_{2 α} (Cosynch + IPI; $n = 265$). Most cows were inseminated at the second GnRH injection ($n = 460$), but 84 cows were inseminated 16 to 18 h after that injection at one station. Blood samples were collected at d -17, -7, 0, and +2 relative to PGF_{2 α} to determine concentrations of progesterone. Ultrasonography was used to determine the presence of a fetus at 30 to 35 d after insemination. Pregnancy rates tended ($P = .13$) to be greater for Cosynch + IPI (58%) than for Cosynch (48%) treated cows. No station \times treatment interaction occurred; however, MO (63%) and KS (60%) had greater ($P < .05$) pregnancy rates than IL (48%) and MN (44%). Cows in greater body condition at the onset of the breeding season experienced improved ($P < .001$) overall pregnancy rates. Pregnancy rates for cows that calved > 50 d before the onset of the breeding season were greater ($P < 0.01$) than those which calved ≤ 50 d. Thus, treatment of suckled cows with Cosynch yields acceptable pregnancy rates; addition of an IPI may improve overall pregnancy rates. Body condition and days postpartum at initiation of the breeding season affect overall efficacy of the Cosynch and Cosynch + IPI protocols.

Key Words: Beef Cows, Estrous Synchronization

919 Improved synchronization of estrus in postpartum suckled beef cows with a progestin-GnRH-prostaglandin F_{2 α} (PG) protocol. D. J. Patterson^{*}, S. L. Wood, F. N. Kojima, and M. F. Smith, *University of Missouri, Columbia*.

This experiment was conducted to determine whether treatment with the oral progestin, melengestrol acetate (MGA), prior to GnRH and PG would improve estrous response and synchrony of estrus in postpartum suckled beef cows compared to cows synchronized with GnRH and PG. Multiparous Angus crossbred cows ($n=110$) were assigned by age, body condition score (BCS) and days postpartum (dpp) to one of two treatments. Cows were fed a ground corn supplement for 14 d (1.8 $\text{kg}\cdot\text{hd}^{-1}\cdot\text{d}^{-1}$) with or without MGA (0.5 $\text{mg}\cdot\text{hd}^{-1}\cdot\text{d}^{-1}$). GnRH (100 μg Cystorelin[®]) was administered to all cows 10 d after MGA or carrier withdrawal and 7 d before PG. Mean BCS and dpp for MGA and control cows at the initiation of treatment was 5.1 and 5.0, and 44 and 42 dpp, respectively. Blood samples were collected from all cows 10 d before and on the first day of MGA or carrier, and 7 d before and on the day PG was administered. Concentrations of P₄ in serum at the initiation of treatment were elevated (> 1 ng/ml) in 49% of the MGA and 43% of the control cows. Cows were observed for signs of behavioral estrus for 7 d after PG and inseminated 12 h after observed estrus. Estrous response was higher ($P < .09$) among MGA treated cows compared with controls [89% (50/56), and 77% (42/54), respectively]. However, there was no difference between treatments in the total number of cows that exhibited estrus during the peak synchronized period from 48 to 96 h

after PG (MGA-77%, controls-68%). Synchronized conception (SCR:no. pregnant/no. inseminated) and pregnancy rate (SPR:no. pregnant/no. treated) did not differ between treatments [SCR=78% (39/50), 76% (32/42); SPR=70% (39/56), 59% (32/54) for MGA and control cows, respectively]. In summary, this sequential approach to estrous cycle control of postpartum suckled beef cows (progesterin-GnRH-PG) offers significant potential to effectively synchronize estrus with resulting high fertility.

Key Words: Progesterin, Postpartum cow, Estrus synchronization

920 Reduced dose GnRH in Select Synch and CO-Synch protocols to synchronize estrus or ovulation in beef cows. B.W.P. Sasongko¹, J.C. Whittier^{*1}, T.W. Geary², D.N. Schutz¹, E.R. Downing¹, P. Burna¹, R.G. Mortimer¹, and G.E. Seidel, Jr., ¹Colorado State University, Ft. Collins, ²Livestock and Range Research Center, Miles City, MT.

Two studies were conducted using half dose (50 μ g) GnRH injections with Select Synch and CO-Synch synchronization protocols in beef cows. In Trial 1 (Select Synch), primiparous (P1) and multiparous (Pn) cross-bred cows at two locations (L1, n = 241; L2, n = 334) received 50 μ g or 100 μ g GnRH on d 0 of the study. On d 7, all cows received 25 mg of PGF2 α . Estrous detection and am/pm AI took place from d 7 to d 12; clean-up bulls were turned in on d 13. Location had no effect on number of cows observed in estrus, therefore data were pooled across location. There was no difference due to treatment (Trt) in synchronization rate (P=.96; 100 μ g = 54.9% (173/315), 50 μ g = 55.1% (171/292)). AI conception rate determined by ultrasound 45 d after AI at L2, was not affected by the Trt (P=.22; 100 μ g = 59.6% (55/94), 50 μ g = 50.5% (47/93)). In Trial 2 (CO-Synch), cows received either 50 μ g or 100 μ g GnRH on d 0 and d 9, and 25 mg PGF2 α on d 7. At L3, 204 P1 and Pn Angus cows were assigned to one of four Trt in a 2x2 factorial with day and dose as factors. (i.e. 50:50, 50:100, 100:50, 100:100). At L4, 98 Pn cows received 100 μ g or 50 μ g of GnRH on both d 0 and d 9 (i.e. 50:50 or 100:100). Calves were removed from d 7 to d 9, cows were mated by am/pm AI up to 48 h post PGF2 α , then cows not observed in estrus were AI mated. Clean-up bulls went in 14 d after timed AI. Transrectal ultrasonography was used to determine pregnancy at 40 d after timed AI at L4 and 61 d at L3. Location did not affect synchronization or AI pregnancy rates; therefore data were pooled. There was no difference in synchronization rate between Trt. Dose reductions of GnRH had no effect on AI pregnancy rate (P=.65; 100:100 = 46.2% (48/104), 100:50 = 42.3% (22/52), 50:100 = 49.0% (24/49), 50:50 = 39.2% (38/97)). We conclude that 50 μ g of GnRH was sufficient to induce fertile estrus and ovulation in beef cows in both synchronization protocols.

Key Words: Synchronized Breeding, GnRH Dose, Beef Cows

921 Effects of estradiol benzoate (EB) on ovulation of newly emerged and mature dominant ovarian follicles in prepubertal heifers. C.R. Burke^{*1,2}, M.L. Mussard¹, and M.L. Day¹, ¹The Ohio State University, Columbus, ²Dairying Research Corporation, Hamilton, New Zealand.

Prepubertal heifers were used in a 2 x 2 factorial design to test the hypotheses that: I) an injection of estradiol benzoate (EB) 24 h after withdrawal of an intravaginal progesterone insert (CIDR) will increase the incidence of a detected estrus independent of maturity of the dominant follicle (DF); but that, II) newly emerged DF will not ovulate despite estrus having been induced with EB. Prepubertal beef heifers (n=31) weighing 323 \pm 5 kg (mean \pm SEM) and 306 \pm 6 d of age each received a CIDR and an i.m. injection of 1 mg EB/500 kg BW. Daily ultrasonography detected the emergence of a new follicle wave 3.1 \pm .1 d after treatment initiation. Allocation to the 4 treatment groups was balanced for day of new emergence. The CIDR was removed 1.3 \pm .1 d (Young DF; n=15) or 4.2 \pm .1 d (Mature DF; n=16) after emergence of the new follicle wave, and heifers within each group received either an injection of EB (.75 mg/500 kg BW) 24 h after CIDR withdrawal, or no further treatment. Expression of behavioral estrus was monitored by twice daily observations. Diameter of DF at the time of CIDR withdrawal was greater (p<.01) in heifers of the Mature DF (9.1 \pm .4 mm) than the Young DF Group (6.7 \pm .2 mm). Most heifers receiving EB 24 h after progesterone withdrawal were detected in estrus (15/16) and ovulated (12/15). Maturity of the DF did not affect (P>.1) these responses. Age of the DF at ovulation was 3.6 \pm .2 d and 6.4 \pm .2 d for heifers in Young DF and Mature DF groups, respectively (p<.01).

Among animals that did not receive EB, a single heifer ovulated and none were detected in estrus within 5 d of CIDR withdrawal. We conclude that EB is effective in inducing estrus, and ovulation of newly emerged or mature DF in prepubertal heifers previously treated with progesterone and EB.

Key Words: Puberty, Cattle, Estradiol

922 Evaluation of four selective media for isolation of catalase-negative gram-positive cocci from bulk tank milk. B. Jayarao^{*}, S. Pillai, and A. Sawant, Pennsylvania State University, University Park.

Four selective media (Edward's agar, TKTFC agar, COEBA agar, and Streptococcal Agar) were tested on three separate occasions with a battery of gram positive (cocci and bacilli) and gram negative bacteria. Based on experimental inoculation, it was inferred that COEBA agar was highly selective for Streptococci. Growth of organisms belonging to the genera Lactococcus, Enterococcus and Aerococcus were not inhibited by the media, however the colony size was considerably smaller as compared to that on regular 5% sheep blood agar plates. All of the 9 Staphylococcal organisms and gram positive bacilli tested were completely inhibited by COEBA agar. Further, when farm bulk tank samples (n = 105) were examined for Streptococci using COEBA agar, the medium permitted growth of catalase negative bacteria belonging to the genera Streptococcus, Enterococcus, Lactococcus and Aerococcus. Growth of Staphylococci, gram-positive bacilli, and gram-negative bacteria present in bulk tank milk were completely inhibited on COEBA agar. Results of the study suggest that although COEBA agar does not exclusively select for Streptococci, COEBA agar does give a differential count of catalase-negative gram-positive cocci, many of which are useful indicators of milk hygiene and milking practices followed on the farm. It is recommended that COEBA agar can be used for isolation of catalase-negative gram-positive cocci from bulk tank milk.

Key Words: COEBA agar, Streptococci, bulk tank milk

923 Physiological responses of Holstein cows to bovine somatotropin (bST) treatments during the transition period. M. S. Gulay^{*1}, A. Garcia-Gavidia², C. J. Wilcox¹, J. M. Hayen¹, and H. H. Head¹, ¹University of Florida, Gainesville, ²Universidad del Zulia, Maracaibo, Venezuela.

Objectives were to determine effects of linear doses of bST prepartum and postpartum on DMI, BCS, BW, MY and some metabolic and lactogenic hormones and P₄ in plasma collected thrice weekly during experiment. Associations among metabolic hormones, IGF-I, P₄ and postpartum production and reproductive activity were evaluated. Twenty-three Holstein cows were assigned randomly to four groups (7, 5, 6, and 5 cows/group). Treatments included prepartum and postpartum biweekly injections of bST (I-IV; 0, 6, 12, or 18 mg bST/d) and evaluation of DMI, BCS, BW, MY and metabolic hormones and metabolites. Mathematical models included main effects of treatment, calving month, the 2-way interaction, and cow nested in treatment-calving month. Data were divided into prepartum and postpartum sets. Prepartum bST treatments for I to IV, respectively, resulted in higher mean concentrations of ST (4.0 \pm 0.8, 3.5 \pm 0.9, 15.1 \pm 0.8, and 16.0 \pm 1.2 ng/ml, P<0.06), PRL (19.8 \pm 2.5, 40.1 \pm 2.8, 31.4 \pm 2.2, and 25.8 \pm 3.9 ng/ml, P<0.09), and IGF-I (109.2 \pm 4.4, 153.7 \pm 5.2, 158.4 \pm 5.1, and 185.6 \pm 6.9 ng/ml, P<0.07). Postpartum treatments (12 and 18 mg bST/d) resulted in increased concentrations of ST (6.2 \pm 0.5, 4.4 \pm 0.6, 18.3 \pm 0.5, and 20.1 \pm 0.8 ng/ml, P<0.005), IGF-I (73.9 \pm 2.1, 69.9 \pm 2.6, 85.5 \pm 2.2 and 83.0 \pm 4.4 ng/ml, P<0.09), T₃ (524.7 \pm 14.7, 503.3 \pm 17.5, 598.6 \pm 16.2 and 992.0 \pm 21.7 pg/ml, P<0.08) and numerically greater MY (30.93, 31.23, 32.03, and 34.93 kg/d). Treatment affected mean DMI during early postpartum period (0-21d; P<0.08). Cows in groups III and IV maintained BCS better (P<0.025) than groups I and II. Treatment group IV had numerically higher mean plasma glucose concentrations. Early postpartum treatments (d 7 to d 21) increased mean plasma concentrations of NEFA for high doses of bST (III and IV vs I and II; 342.1 \pm 9.3 vs 241.4 \pm 8.2 μ eq/ml). No effects of bST treatment were observed on plasma concentrations of INS, P₄, plasma protein or hematocrit. No adverse effects of bST treatment were observed in cows during either the prepartum or postpartum periods.

Key Words: bST, Transition, Lactation

924 Responses of Holstein cows to prepartum and postpartum injections of bovine somatotropin (bST). A. Garcia-Gavidia², M. S. Gulay*¹, M.J. Hayen¹, C.J. Wilcox¹, T.I. Belloso¹, and H.H. Head¹, ¹University of Florida, Gainesville, ²Universidad delZulia, Maracaibo, Venezuela.

Objectives were to evaluate effects of bST treatment prepartum and/or postpartum and postpartum diets on DMI, energy status, BCS, BW, MY, metabolic and lactogenic hormones, and P₄ in plasma. Four to 5 wk prepartum 48 Holstein cows were assigned to two groups of 24 cows each. Prepartum treatments were bST (~6 mg bST/d) or no bST beginning 3 wk before expected calving. Postpartum the experiment was arranged as a 2x2x2 factorial considering bST prepartum and postpartum and two postpartum diets (0 and 15% whole cottonseeds). Pre- and postpartum data were analyzed separately. Mathematical model for prepartum period included effects of bST, cow in treatment, and days to cubic order polynomial. For data from calving to 65 d postpartum the model included prepartum and postpartum bST treatment, postpartum diet, appropriate 2 and 3-way interactions, cow nested in treatment groups, effects of BW and BCS, and days to cubic order polynomial. Associations among metabolic and lactogenic hormones, IGF-I, P₄, and postpartum MY were evaluated. For prepartum period, mean DMI for groups did not differ (~15kg/d) but decreased in both groups ~35% (backslash) during week before calving. Energy status was positive and not different due to treatment (2.04 and 2.40 Mcal/d for bST and no bST groups). Mean concentrations of ST and glucose were greater (P<0.002 and P<0.03) in bST-treated cows. No effects of bST on mean concentrations of PRL, INS, T₄, T₃, IGF-I were detected during the prepartum period, but concentrations of IGF-I and INS decreased as parturition approached. For the postpartum period, no significant effects of prepartum bST, diet or their interaction were detected on DMI, MY, energy status or concentrations of ST, INS, or IGF-I during first 65 d of lactation. Postpartum bST treatment increased ST concentration ~2-fold vs uninjected. Ovarian activity, measured by accumulated P₄ during 65 d postpartum, did not differ due to treatment or diet. MY was numerically greater (39.27 vs 37.69 kg/d) in cows treated with bST postpartum and also for cows fed whole cottonseed diet.

Key Words: Transition, bST, Lactation

925 Effect of fan and sprinkler configuration upon summer milk production of cows housed in 2-row freestall barns. M.J. Brouk*, J.F. Smith, J.P. Harner III, and J.E. Shirley, *Kansas State University, Manhattan.*

One hundred fifty-nine Holstein cows (66 primiparous and 93 multiparous) were blocked by parity, milk production and DIM then assigned to one of three cooling systems installed in 2-row freestall barns. Barn one (F&S) was equipped with a row of five 122 cm fans mounted every 12 m over the freestalls and a row of ten 91 cm fans mounted every 6 m over the feedline. Barn two (S) was equipped with five 122 cm fans mounted every 12 m over the freestalls. Both barn one and two were equipped with a feedline sprinkler that delivered 95 l of water in 3 min during a 15 min cycle. Sprinklers cycled every 15 min when the temperature exceeded 24°C. Barn 3 (S+) was equipped with five 122 cm fans mounted every 12 m over the freestalls and a sprinkler line on both the feedline and rear alley. The sprinkler operation was the same as barns one and two except 132 l of water were applied during each cycle. Fans in all treatments operated when temperatures exceeded 21°C. Cows were milked 2x and production for a 24-hour period was recorded every two weeks during the study. Pen intakes were recorded daily and body condition score was determined at the start and end of the study. Respiration rates were recorded on three separate days during heat stress. Temperature and humidity data were recorded continuously in each barn throughout the study. Average milk production during the 85 day trial was similar (P>.05) for all treatments (36.6, 36.4, and 35.1 kg/cow/day for F&S, S and S+ treatments, respectively). Primiparous and multiparous animals did not differ (P>.05) in milk production response to the systems. Afternoon respiration rates did not differ among treatments (83.2, 82.8 and 80.0 breaths/min, respectively). Cows housed in 2-row freestall barns did not produce more milk when fans were installed over the feedline in addition to freestall fans. Increasing sprinkler area did not increase milk production in 2-row freestall barns.

Key Words: Heat Stress, Cow Cooling, Dairy Facilities

926 Effect of fan configuration on summer milk production of dairy cows housed in a 4-row freestall barn. M.J. Brouk, J.F. Smith, J.P. Harner III, and J.E. Shirley, *Kansas State University, Manhattan.*

Ninety-three multiparous Holstein cows averaging 130 DIM at the start of the study were housed in a 4-row freestall barn. Cows were blocked by parity and production and allotted to one of three cooling treatments. Treatment one (2S) was a double row of 91 cm fans, spaced 7.3 m apart over the freestalls. Treatment two (F&S) was a single row of 91 cm fans, spaced 7.3 m apart over the freestalls and feedline. Treatment three (F&2S) was a double row of 91 cm fans spaced 7.3 m apart over the freestalls and a single row of 91 cm fans, spaced 7.3 m apart over the feedline. Fans operated when air temperatures exceeded 21°C. All three treatments had feedline sprinkler systems that delivered 189 l of water during a 3 min of a 15 min cycle. Sprinklers cycled every 15 min when air temperature exceeded 24°C. Cows were milked 3x and milk weights recorded for a 24-hour period every two weeks throughout the 85 day trial. Daily pen feed intake was also recorded. Respiration rates were observed 3 times during the trial and body condition scores were evaluated at the beginning and end of the trial. Temperature and humidity in each pen and outside the barn were recorded continuously throughout the trial. Cows cooled with treatment F&S produced more (P<.05) milk (44.8 vs 42.6 kg/c/d) than 2S while F&2S (43.8 kg/c/d) was intermediate and similar (P>.05) to both. Afternoon respiration rates (83.9, 72.3 and 70.6 breaths/min, respectively) were greater (P<.05) for cows cooled with 2S compared to the other treatments. In a 4-row freestall barn equipped with a feedline sprinkler system, installing fans over the feedline and over the freestalls increased milk production when compared to fans just over the stalls.

Key Words: Heat Stress, Cow Cooling, Dairy Facilities

927 Endocrine changes associated with the effect of nutrition on postpartum anestrus and reconception in dairy cows. G. Luna-Pinto* and P.B. Cronje, *University of Pretoria, Gaugteng, South Africa.*

The aim of this study was to determine whether plasma concentrations of IGF-1, IGFBP-3, leptin or glucose were associated with postpartum reconception in Friesian cows fed at two different planes of nutrition. Multiparous Friesian cows were fed one of two diets: 80 % or 120 % of requirements from calving until conception. Blood samples were collected weekly until conception. Cows fed at 120 % of requirements were heavier (P < 0.05) than cows fed at 80 % of requirements at the time of conception. Cows fed at 80 % of requirements lost 119 g/d body weight (P < 0.05) and 26 % of initial body condition score (P < 0.01) from week 2 to conception. Nutritional treatment influenced the interval from calving to conception (P < 0.05). Cows fed at 80 % of requirements expressed estrus and became pregnant at 118 +/- 11 d postpartum and cows fed at 120 % of requirements at 48 +/- 10 d. Neither level of nutrition nor sampling period had any effect (P > 0.05) on plasma concentration of IGF-1 (51.1 +/- 6.68 ng/ml) or glucose (3.8 +/- 0.3 mmol/l). Plasma IGFBP-3 concentration increased from week 2 to conception for both treatments (P < 0.01), but concentrations in cows fed at 120 % of requirements were higher than those fed at 80 % of requirements in both instances (P < 0.01). Plasma IGFBP-3 concentration increased from week 2 to conception by 133 % in cows fed at 120 % of requirements and 85 % in cows fed at 80 % of requirements. At week 2, cows fed at 120 % of requirements had 85 % greater plasma IGFBP-3 concentrations than cows at 80 % of requirements. At conception, plasma IGFBP-3 concentrations were 115 % greater in cows fed at 120 % of requirements than those fed at 80 % of requirements. There were no differences in plasma leptin concentrations between dietary treatments (P > 0.05), but concentrations were higher at conception (P < 0.05) than at week 2 postpartum. This study demonstrates that plasma IGFBP-3 concentration can be used as a predictor of days open in cows fed different diets.

Key Words: Reconception, Insulin-like growth factor system, Leptin

928 Effect of fat on plasma hormones and metabolites in early lactation grazing dairy cows. G.F. Schroeder^{*1}, D. Becu-Villalobos², I. Lacau-Mengido², and G.A. Gagliostro³, ¹CONICET- Fac. Cs. Agrarias UNMDP, ²IBYME-CONICET, ³INTA EEA Balcarce, Argentina.

Thirty-seven multiparous Holstein cows were studied during the first 70 days of lactation in a complete randomized design with three treatments: 0 kg (T0, 12 cows), 0.5 kg (T0.5, 12 cows) and 1 kg (T1, 13 cows) of dried oil (30% C16:0 and 60% C18:0). Fat was added to a basal concentrate (5 kg/d ground corn, 0.4 kg/d fish meal and 20 g/d chloride calcium) starting 2 weeks before the expected calving date. Cows grazed a spring pasture (1.98±0.82 tDM/ha, 30±8 kgDM/cow/d) with 24.4% DM, 38.3% NDF, 23.4% CP and 73.2% IVDMD. Jugular blood was sampled on days 15, 30, 45 and 60 of lactation. Plasma immunoreactive growth hormone (GH), insulin (INS) and insulin-like growth factor-I (IGF-I) were analyzed at days 30 and 60 postcalving. On day 34, jugular blood samples were taken before and 15 min after an intravenous injection of isoproterenol (ISO). On day 37, samples were taken before and 15, 30 and 60 min after INS injection. Glucose and NEFA responses were evaluated. Treatment x time of sampling interaction was not detected for metabolite concentrations (P≥.1). Glucose, plasma urea nitrogen and NEFA were not affected by fat. NEFA decreased gradually as lactation advanced. Plasma triglycerides were lower (T1= 271a, T0.5= 292ab and T0= 318b mg/dl, P≤.05) and total cholesterol higher (T1= 236a, T0.5= 218ab and T0= 185b mg/dl, P≤.02) in T1 compared to control. Responses to ISO or INS injection were not affected by treatments. Average plasma hormone concentrations were not changed by fat (P≥.1). Treatment x time of sampling interaction was not detected and plasma GH and IGF-I concentration increased whereas INS decreased (P ≤.05) as lactation advanced. In early lactation, saturated fat did not reduce circulating NEFA, responsiveness of adipose tissue to lipolytic stimulation and the hypoglycemic or antilipolytic action of INS. Concentrations of NEFA and hormones were affected by lactation stage but not by saturated fat feeding.

Key Words: Fat supplementation, Early lactation, Metabolites and hormones

929 Effect of level of feed intake on plasma progesterone concentrations in deslorelin-implanted dairy cows treated with a CIDR device. A.R. Rabiee^{*1}, K.L. Macmillan¹, and F. Schwarzenberger², ¹University of Melbourne, Melbourne, Australia, ²University of Veterinary Medicine, Vienna, Austria.

The amount of feed, frequency of feeding and diet composition may influence concentrations of plasma progesterone (P4) by altering the metabolic rate rather than P4 production rate. In the present study, an external source of P4 was administered to investigate the effect of the level of feeding on P4 concentrations. Twelve non-lactating Holstein-Friesian cows, 4-9 years old were randomly allocated to a restricted or ad libitum group. The ad libitum group had unrestricted access to graze irrigated pasture, whereas the restricted group had access for only 2h/day. Each animal was drenched orally twice daily with a chronic oxide capsule to allow daily feed intake to be estimated from fecal output. Endogenous P4 production was eliminated by subcutaneously implanting a capsule containing 6mg of a potent GnRH agonist (deslorelin) into the ear of each animal 3 weeks before inserting a CIDR device containing 1.9g P4 into the vagina. Each device was removed after 11 days and residual P4 measured. Plasma from blood samples taken daily was assayed for P4. The average daily dry matter intake of pasture was higher for cows in the ad libitum group (15.9 vs 6.3 kg DM, P<0.01) but their plasma P4 concentrations were lower (1.08 vs 1.71 ng/ml; p<0.05) even though the residual P4 content of the used CIDR devices was not affected by feed intake (1.20 vs 1.25g; P>0.3). Plasma P4 concentrations in blood samples taken the day before device insertion or following removal were below the sensitivity of the assay. These results show that there was a negative relationship between feed intake and plasma P4 concentrations in these CIDR-treated GnRH downregulated Holstein cows.

Key Words: Progesterone, Feed intake

930 Effect of level of feed intake on the concentration and yield of fecal progesterone metabolites in deslorelin-implanted dairy cows treated with a CIDR device. A.R. Rabiee^{*1}, K.L. Macmillan¹, and F. Schwarzenberger², ¹University of Melbourne, Melbourne, Australia, ²University of Veterinary Medicine, Vienna, Austria.

Progesterone is rapidly metabolized by the liver then excreted into the bile and voided in the feces. In the present study, an external source of progesterone (P4) was administered to investigate the effect of level of feeding on the concentrations and daily yield of fecal P4 metabolites (FP4M). Twelve non-lactating Holstein-Friesian cows, 4-9 years old were randomly allocated to a restricted or ad libitum group. The ad libitum group had unrestricted access to graze pasture, whereas the restricted group had access for only 2h/day. Each animal was drenched orally twice daily with a chronic oxide capsule to allow daily feed intake to be estimated from fecal output. Endogenous P4 production was eliminated by subcutaneously implanting a capsule containing 6mg of a potent GnRH agonist (deslorelin) into the ear of each animal 3 weeks before inserting a CIDR device containing 1.9g P4 into the vagina. Each device was removed after 11 days and residual P4 content measured. Fecal samples were taken daily and assayed for pregnanes containing a 20-oxo- or a 20 α - or a 20 β -OH group with EIAs. The average daily dry matter intake of pasture and fecal output were higher for cows in the ad libitum group (feed intake:15.9 vs 6.3, fecal output: 5.4 vs 2.5 kg DM; P<0.01). The residual P4 content of the used CIDR devices was not affected by feed intake (1.20 vs 1.25g; P>0.3). The concentrations of FP4M were not affected by level of feed intake (20-oxo-: 3.3 vs 1.7, 20 α -: 3.5 vs 3.7, 20 β -: 2.1 vs 3.2 mg/ g DM; P>0.05). Daily yields of 20-oxo- and 20 α - were higher in ad libitum cows (20-oxo-: 17.8 vs 4.3; P<0.05, 18.2 vs 8.9 mg/day; P<0.001) whereas daily yield of fecal 20 β - was not affected by feed intake (11.9 vs 8.6 mg/day; P>0.5). These data showed that FP4M concentrations were not affected by level of feed intake or faecal output, but the volume of feces altered the daily excretion rate of FP4M.

Key Words: Fecal progesterone metabolite, Feed intake

931 Liver blood flow and steroid metabolism are increased by both acute feeding and hypertrophy of the digestive tract. S. Sangsritavong^{*}, D.K. Combs, R.F. Sartori, and M.C. Wiltbank, University of Wisconsin, Madison.

Steroid metabolism primarily occurs in the liver. We hypothesized that changes in liver blood flow are due to acute feed consumption or growth of the digestive tract that could produce important alterations in steroid metabolism. To test this hypothesis, liver blood flow and steroid metabolism were evaluated in 2 experiments. Exp.1 evaluated the acute (0-6 h post feeding) effect of feeding in high producing lactating cows. Exp.2 evaluated the chronic effect of high feed consumption by comparing weight-matched lactating (high feed consumption) and dry (low feed consumption) cows. In both experiments liver blood flow was measured by continuous infusion of bromosulfothalein (BSP), which is specifically metabolized in the liver. Steroid metabolism was measured by continuous infusion of progesterone and estradiol 17 β . Stable steady state serum concentration of all three compounds were achieved within 0.5 h of infusion. The steady state concentration was used to calculate the clearance rate for each compound. Acute feeding increase liver blood flow (BSP clearance) from 1035 to 1637 l/h (158%) by 4 h after feeding (n=2). In contrast, liver blood flow decreased (83% of control) when cows were left un-fed during the same time. In Exp.2, lactating (n=4) and dry (n=3) cows had liver blood flow and steroid metabolism measured on 3 consecutive days at 3-5 h after feeding. Although variability between cows was substantial (CV=13.5% in lactating cows and 27.7% in dry cows) the variability between days for an individual cow was relatively low (CV=4.8% in lactating cows and 5.5% in dry cows). Lactating cows had greater (p<0.01) liver blood flow (1184±69 vs.756±120 l/h) and lower serum concentration of progesterone (2.3±0.13 vs. 3.55±0.25 ng/ml) and estradiol (265±2.7 vs. 352±6.8 pg/ml). Thus liver blood flow and concomitant steroid metabolism is acutely (>50% within 4 hour) and chronically (>50% higher in high feed intake cows) increased by feeding. Decreases in reproductive efficiency in high producing dairy cows may be mediated by high steroid metabolism due to high feed consumption and elevated liver blood flow.

Key Words: Liver blood flow, Steroid metabolism, Reproductive efficiency

932 Effect of conjugated linoleic acids (CLA) on parameters of adipose tissue metabolism in the lactating dairy cow. L.H. Baumgard*, B.A. Corl, S.S. Block, D.A. Dwyer, Y.R. Boisclair, and D.E. Bauman, *Cornell University, Ithaca, NY.*

CLA have profound impact on lipid metabolism. Feeding CLA at 1-2% of the diet dramatically reduced body fat content in growing mice, rats and pigs. Effects are also observed in lactating dairy cows where CLA at 10 to 20-fold lower concentrations markedly reduces milk fat synthesis. This reduction in milk fat is specific for the *trans*-10, *cis*-12 CLA isomer and shifts milk fat composition toward greater proportions of long chain fatty acids. The mechanism(s) by which CLA affects lipid metabolism is not clear, but postulated effects have included increased lipolysis. Our objectives were to evaluate the effects of CLA isomers on circulating concentrations of nonesterified fatty acids (NEFA) and the lipolytic response to a β -adrenergic challenge. We also evaluated circulating leptin given the reported role of this signal in storage and use of energy. Three multiparous Holstein cows (183 ± 8 DIM) were utilized in a 3x3 Latin square design. Treatments consisted of 5-d abomasal infusion of 1) control, 4L of skim milk/d, 2) 9,11 CLA, 10 g/d of *cis*-9, *trans*-11 CLA isomer and 3) 10,12 CLA, 10 g/d of *trans*-10, *cis*-12 CLA isomer. Basal concentrations of NEFA were determined on d 4. Epinephrine challenges (1.4 μ g/kg body weight) were intravenously administered at 9:00 am and 3:00 pm on d4. Plasma samples (n=19) were obtained from a jugular catheter and area under the NEFA response curve (0 to 30 min, AUC) was quantified after correcting for basal concentrations. Basal NEFA concentrations (139 μ mol/l) were not altered by treatment. NEFA response to epinephrine challenge was effected by treatment being reduced by 39% for the 10,12 CLA as compared to the other treatments (P<0.05). Treatments had no effect on plasma leptin concentrations which averaged 3.1 ng/ml. Overall, data demonstrate that the *trans*-10, *cis*-12 CLA isomer which caused milk fat depression had no chronic effect on NEFA concentrations (basal lipolysis) or circulating leptin concentrations, but did give a modest reduction in the lipolytic response to an epinephrine challenge.

Key Words: CLA, NEFA

933 Acute nutritional restriction alters endocrine function and causes anovulation in beef heifers. F.J. White*, C.A. Lents, L.N. Floyd, L.J. Spicer, and R.P. Wettemann, *Oklahoma Agricultural Experiment Station, Stillwater.*

Effect of acute nutritional deprivation on ovarian luteal function and plasma concentrations of glucose, insulin, IGF-I, NEFA, and thyroxine was determined in 14 mo old Angus x Hereford heifers (BCS=5.7; 317 ± 2 kg BW). Heifers (n=19) were housed in individual pens in a barn and fed a diet supplying 1.2 x maintenance (1.2 M) for 1 wk to allow adaptation. Heifers were then randomly allotted on d 0 to either a diet supplying .4 x maintenance (.4 M) or 1.2 M. Heifers were treated with PGF on d -10, 0, and 10. Blood plasma was collected via tail venipuncture on alternate days. Heifers with plasma progesterone less than .5 ng/mL on d 15 to 21 were classified as anovulatory. Heifers on .4 M (306 ± 2 kg) lost BW (P < .01) while 1.2 M heifers (321 ± 2 kg) maintained BW. Seventy percent of .4 M heifers did not ovulate on d 14 while all

1.2 M heifers had normal luteal function. Nutritional restriction for 14 d did not alter plasma glucose or insulin. Heifers on .4 M had less plasma thyroxine (32.3 ± 1.7 ng/mL) than 1.2 M heifers (40.9 ± 1.7 ng/mL; P < .01). A day x diet (P < .01) effect on plasma NEFA was due to 1.2 M heifers maintaining NEFA concentrations while .4 M heifers had increased concentrations. Nutritional restriction decreased concentrations of plasma IGF-I in .4 M heifers from 50.5 ± 2.3 ng/mL on d 0 to 28.5 ± 2.3 ng/mL on d 14; however, 1.2 M heifers maintained concentrations (54.9 ± 2.3 and 58.4 ± 2.3 ng/mL on d 0 and 14, respectively; day x diet; P < .01). Acute nutritional restriction induced anovulation in 70% of heifers within 14 d, and plasma concentrations of NEFA increased while IGF-I decreased.

Key Words: Beef heifer, IGF-I, NEFA

934 Effect of source of Romosinuano germplasm and preweaning creep grazing on postweaning growth and puberty in heifers. C. C. Chase, Jr.*¹, M. J. Williams¹, A. C. Hammond², and T. A. Olson³, ¹USDA, ARS, Brooksville, FL, ²USDA, ARS, Albany, CA, ³University of Florida, Gainesville.

Postweaning growth and puberty were determined for Romosinuano heifers from germplasm collected in Costa Rica (CR; n = 17) and Venezuela (VE; n = 34) that 98 d prior to weaning were either allowed to creep graze rhizoma peanut (*Arachis glabrata*; RP; n = 26) or no creep (n = 25). Postweaning, heifers were initially managed as a single group, then as two groups during a 90 d breeding season, and thereafter as a single group until the end of the study. Heifers were maintained on mixed bahiagrass (*Paspalum notatum*) and RP pastures (and hay) and fed 4.5 kg/d concentrate. Growth measurements were collected at the start of the study and at 28-d intervals for 358 d. Beginning three wk before the start of the breeding season and at 7-d intervals thereafter, blood was collected and plasma progesterone determined by EIA to assess puberty. At the start of the study, heifers from CR were older (236 vs 208 d; P < .01), heavier (218 ± 7.1 vs 183 ± 5.0 kg; P < .001), and taller (113 ± 1.2 vs 110 ± 0.8 cm; P < .05) than heifers from VE. At the end of the study, heifers from CR were heavier (432 ± 9.1 vs 387 ± 6.4 ; P < .001) and taller (132 ± 1.1 vs 129 ± 0.8 cm; P < .05) than heifers from VE. During the study, however, neither gain in BW (214 ± 5.9 vs 204 ± 4.2 kg, for CR vs VE, respectively) nor gain in hip height (19.0 ± 1.0 vs 19.5 ± 0.7 cm) were affected by source of germplasm. Preweaning treatment did not affect BW or hip height at the start or end of the postweaning study; but non creep calves gained more (P < .05) BW than creep calves during the postweaning study (216 ± 0.8 vs 202 ± 0.8 kg). Age at puberty was similar between heifers from CR (428 ± 8.5 d) and VE (419 ± 6.0 d) and between creep (419 ± 3.3 d) and non creep (427 ± 3.4 d) heifers. Hip height (P < .10) and BW (P < .05) at puberty were influenced by the interaction of germplasm source x preweaning treatment. This appeared due to taller hip heights and heavier BW observed at puberty for CR-non creep heifers than for any of the other source-treatment combinations. Data from this study suggest that CR and VE heifers have similar postweaning growth rates and ages at puberty and that preweaning creep may depress postweaning gain in heifers but did not affect age at puberty.

Key Words: Heifers, Tropics, Puberty

PRODUCTION AND MANAGEMENT

935 Effects of two winter feeding methods on growth, conception, and cost of developing beef replacement heifers. C. L. Gasser*, E. W. Hawkins, R. W. Silcox, and C. W. Wiltbank, *Brigham Young University, Provo, UT.*

Performance of beef replacement heifers is crucial to a cow-calf operation, but heifer development is a major cost. The objective of this study was to determine whether beef heifers could be developed using low-cost winter pasture without compromising growth and reproductive performance. Crossbred Angus heifers were wintered on pasture residue with supplemented grass hay (P; n=40) or in drylots fed grass hay (D; n=40) for 77 days. Heifer age on d 1 ranged from 7.5 to 9.5 mo. Initial BW for P and D was 268 kg and 266 kg, respectively. Beginning on d 78, all heifers were sorted by weight and fed the same ration to reach breeding weight at d 120. Heifers were weighed on d 1, 23, 44, 65, 79, 107, and 121. Body condition score was determined on d 1 and 44. Blood samples taken on d 121 were assayed for progesterone level. Heifers were synchronized for breeding using MGA in the feed (d 89 to 103) followed by a

single LutalyseTM injection on d 121. Heifers detected in estrus between d 122 and 126 were artificially inseminated using the AM/PM rule. All heifers were exposed to a bull from d 141 to 210. Pregnancy was determined by ultrasound on d 167 and 210. The treatment groups did not differ in BW over the course of the study or in blood progesterone levels. The number of heifers that exhibited estrus and received AI did not differ between treatments (p=0.147). D heifers had a higher conception rate from AI (P=46%; D=73%; p=0.033). However, overall pregnancy rate on d 210 did not differ between treatments (P=86%; D=95%). The overall cost of development was higher for D than P. There is evidence that beef replacement heifers may be developed using low-cost winter pasture without a significant change in overall growth and conception rates. However, to better ensure earlier conception, heifers should be fed a higher quality ration or a better supplement with pasture to avoid weight loss during periods of harsh winter weather.

Key Words: Heifer Development, Conception, Management

936 Effects of feeding beef heifers whole cottonseed or safflower seed during gestation on cold tolerance in newborn calves. R.E. Dietz*, J.B. Hall, and W.D. Whittier, *Virginia Tech, Blacksburg.*

The effects of source of fat in late gestation diets on serum glucose and thermogenic response during short-term cold stress were examined in fall-born neonatal beef calves. Pregnant fall-calving heifers (n = 15) were randomly assigned to three dietary treatments: Control (CON, n=5), Cottonseed (COT, n=5) or Safflower seed supplement (SAF, n=5). Hay-based isonitrogenous and isocaloric diets met NRC requirements while containing 2.0%, 5.0% and 5.0% fat for CON, SAF and COT diets, respectively. Diets were fed for 47.5 \pm 5.4 d before calving. Heifers were weighed weekly and at parturition. At parturition, colostrum samples were taken from the dam, calves weighed, and vigor scores recorded. Calves remained with their dams for 5 h to nurse. At 5.5 h of age, calves were fitted with an indwelling jugular catheter. At 6.5 h of age, calves were placed in a 5C cold room for 90 min. Shivering scores (1= no shivering, 2 = slight shivering 3 = muscle shivering, 4 = severe muscle shivering), rectal temperatures and blood samples were taken every 15 min. Colostrum samples were analyzed for fat, solids, protein, lactose and IgG concentrations. BW and BCS of heifers at calving, and birth weights and vigor scores of calves were unaffected by diet (P>.5). Mean fat, lactose and IgG concentrations in colostrum were not different (P>.3) among treatments. SAF tended to increase colostral solids (P= .1) and protein (P = .13) compared to COT or CON. During cold stress, mean calf body temperature was unaffected, but mean glucose levels tended (P = .12) to be greater and shivering scores were non-significantly increased in CON compared to SAF or COT calves. Glucose concentrations averaged 74.4, 51.9, and 60.0 \pm 7.3 mg/dL, whereas shivering score averaged 2.14, 1.69, and 1.68 \pm .24 in CON, SAF and COT calves, respectively. We conclude that calves from dams fed high fat diets containing safflower seeds or cottonseed respond similarly to cold stress, but these responses are not necessarily consistent with greater cold resistance.

Key Words: Newborn animals, Fats, Cold tolerance

937 Nutrient content of spent microbrewery grains and variation with pub and brew type. B.A. Altizio*, J.E. Wohlt, and P.A. Schoknecht, *Cook College, Rutgers University.*

Brewers' grains have long served as a feedstuff for many livestock species. Large, commercial breweries are the major producer and source of brewers' grains in the U.S. feed industry. Today the popularity and number of microbreweries are increasing. It is questionable whether spent grains produced by smaller brew pubs are comparable to commercial brewers' grains. Therefore a study was conducted to determine the content and variation in nutrients of spent brewers' grains from three local pubs. Over a period of a year, 142 batches of wet spent grains were sampled. Content of DM, and CP, NDF, ADF, hemicellulose, ash, Ca, P, Mg, K, Na (DM basis) averaged 24.8, 20.9, 46.1, 22.3, 23.8, 3.97, 0.22, 0.70, 0.26, 0.07, 0.02%; respectively in spent grains from brew pubs. In comparison, wet brewers' grains (NRC Dairy, 1989) contain 21.0, 25.4, 46.0, 24.0, 22.0, 4.8, 0.33, 0.55, 0.16, 0.09, 0.23%; respectively. Wet microbrewery grains tended to be drier, but contained less CP and ash (all minerals except P) than brewers' grains. Fiber fractions were high in both microbrewed and commercial brewers' grains. All three pubs produced a golden ale (n=10/pub). Spent wet grains from the golden ale brews did not differ in DM or CP content, but did differ in fiber (NDF, ADF, hemicellulose; p<0.01) and mineral (ash, Ca, Mg; p<0.05) content with pub. Brew type (golden ale, pale ale, India pale ale, specialty brews, n=10/brew), all brews produced at one pub, had no influence on nutrient content. Thus, spent grains from a single microbrewery or from multiple breweries are a uniform source of CP; but contain less CP than commercial brewers' grains, possibly due to less soluble carbohydrate extraction and additions of spent microorganisms.

Key Words: Wet microbrewery grains, Brew type, Nutrient content

938 Influence of simulated feedyard dust on performance of market stressed steer calves protected with or without prophylactic antibiotic. N. K. Chirase*^{1,4}, L. W. Greene^{1,4}, C. W. Purdy², B. W. Auvermann¹, R. W. Loan³, D. B. Parker⁴, and M. D. Hoover⁵, ¹Texas Agricultural Experiment Station, Amarillo, ²USDA/ARS, Bushland, TX, ³Texas A&M University, College Station, ⁴West Texas A&M University, Canyon, ⁵Lovelace Respiratory Research Inst., Albuquerque, NM.

Dust from confined animal feeding operations can become extensive during dry environmental conditions. However, there is very little data on the effects of this dust on animal performance. Two experiments (Exp 1 and 2) were conducted to determine the effects of dust on the performance of steers protected or not protected with antibiotic. The simulated dust storm was produced by enclosing cattle in a canvas tent. Calves (Exp 1:n=105, average BW 207 kg; Exp 2:n=120, average BW 210 kg) were purchased in Newport, TN and transported to Bushland, TX. One half of the calves received Micotil[®] (1 ml/30 kg of BW s.c.) in Newport (Exp 2) or at Bushland (Exp 1). Calves were allotted randomly into three dust treatment groups: 1) Control (not exposed to tent and dust), 2) Tent (exposed to tent only) and 3) Dust (exposed to dust suspension inside tent). There were four dust application events, each lasting 1 h (Exp 1; d 0 to 7) or 4 h (Exp 2; d 0 to 23). Calves were weighed approximately every 7 d and ending on d 28. All data were subjected to the analysis of variance using the General Linear Models procedure of SAS. In Exp 1, there was no interaction (P>.05) between Micotil[®] and dust treatment for ADG. The ADG of all dust treatment groups were not different (P>.05). However, ADG for Micotil[®] protected calves was greater (P<.02) than the control (1.18 vs 0.86 kg/d, respectively). In Exp 2, the feed intake for the control, tent and dust groups were 6.6, 6.6 and 5.5 kg/d, respectively. An interaction (P<.05) occurred between dust application and Micotil[®] for ADG. Calves protected with Micotil[®] and exposed to dust had greater (P<.02) ADG than those not protected (1.94 vs 1.26 kg/d). These data suggest that more research is required to determine the role of dust on cattle performance in the feedyard.

Key Words: Steers, Dust, Performance

939 Age and onset of puberty is negatively related to plasma testosterone in Nellore and Santa Gertrudis bulls. A.C. Sanches*¹, R.B. Lobo², and C.D.U. Magnabosco³, ¹Universidade Catolica de Goias,Goiania,GO/Brazil, ²Universidade de Sao Paulo, Ribeirao Preto,SP/Brazil, ³Embrapa Cerros,Planaltina,DF/Brasil.

In order to determine the relationship between the onset of puberty and plasma testosterone, 16 Nellore (N) and 23 Santa Gertrudis (SG) bulls were sampled at 15 day intervals, from 8 to 17 and from 5 to 15 months of age, respectively. Semen samples were obtained by electroejaculation, plasma was obtained by jugular venipuncture and stored at -20C. Plasma testosterone concentrations were measured using a commercial RIA kit (Diagnostic Products Co., Los Angeles, CA). Onset of puberty was determined by the appearance of adequate sperm counts (50 million with at least 10% motility). Bulls were classified into three groups, using a normal distribution and according to the age at puberty: early (E), medium (M), and late (L) sexual maturity. The average ages at puberty were 404.6 \pm 47 and 424.9 \pm 34 days for Nellore and Santa Gertrudis bulls, respectively. Early-maturing bulls reached puberty at similar ages in both breeds. Plasma testosterone concentrations varied between 2.76 and 10.44 ng/mL in N and between 0.09 and 8.31 ng/mL in SG. Overall, correlations between age at puberty and testosterone concentration were very low (P>0.05). In SG bulls, plasma testosterone concentrations were linearly related to age at puberty (P<0.01), however in N bulls there was no relationship. Early-maturing bulls of both breeds, had lower plasma testosterone concentrations than M and L bulls (4.51 \pm 0.0, 5.60 \pm 0.26, and 4.96 \pm 0.42 ng/mL in N and 3.03 \pm 0.74, 5.23 \pm 0.60 and 5.12 \pm 0.35 ng/mL in SG, respectively). These results suggest that the commonly held assumption that early-maturing animals have elevated testosterone in circulation may not always be true. The observation of lower testosterone in early-maturing bulls suggests that there may be lower production, or more rapid clearance of the hormone. Further work on the kinetics of plasma testosterone will be required to resolve this issue.

Key Words: Puberty, Testosterone, Beef cattle

940 Assessment of the BCS system using real-time ultrasound to measure subcutaneous fat at the 12th rib, rump, and shoulder of beef cows at calving, breeding, and weaning. M. F. Browne* and D. E. Eversole, *Virginia Tech, Blacksburg.*

A study was conducted using real-time ultrasound to determine the correlation between body condition scores (BCS) of beef cows with subcutaneous (s.c.) fat thickness during three phases of production. Digitized scans of s.c. fat at three body sites were correlated to accurately predict BCS. Four hundred and twenty-five observations from 203 cows were analyzed. During calving (C), breeding (B), and weaning (W), all cows were weighed, measured at the hip, scanned at the 12th rib (RB), rump (RP), and shoulder (SH). Each cow was assigned a numerical BCS by five experienced observers using a scale from one to nine. Data for BCS were correlated ($P \leq .001$) among the five observers at a value of .89. Body condition scores were highly correlated ($P \leq .001$) with RB, RP, and SH s. c. fat measurements at values of .71, .68, and .68, respectively, for data pooled across all production phases. Hip height had no significant effect on s.c. fat but was significant ($P \leq .05$) when combined with cow weight to predict BCS. Cow weight was significant ($P \leq .001$) when combined with BCS in predicting s.c. fat. Mean s.c. fat measurements for condition scores five through eight were significant ($P \leq .001$) in predicting BCS. These data suggest s. c. fat measurements are highly correlated to BCS and therefore can be used to predict BCS in beef cows during all stages of production. Real-time ultrasound is a useful tool for measuring s. c. fat and therefore predicting BCS of beef cows.

Key Words: Body Condition Score, Ultrasound, Beef Cows

941 Effects of postpartum fat supplementation on reproduction in primiparous 2-year-old and mature cows. J. F. Bader*¹, E. E. D. Felton¹, M. S. Kerley¹, D. D. Simms², and D. J. Patterson¹, ¹*University of Missouri Columbia, Missouri*, ²*Consolidated Nutrition Omaha, NE.*

The objectives of this experiment were to determine the effects of fat supplementation on reproductive rates in primiparous 2-year-old heifers and mature cows. Primiparous 2-year-old heifers and mature cows were assigned to one of three postpartum supplemental treatments. Treatment 1 (FP#1) contained 20.9% EE and 22.2% CP. Treatment 2 was the control group (C) and received a cracked corn and corn gluten ration containing 3.0% EE and 19.0% CP. Treatment 3 (FP#2) contained 16.9% EE and 20.5% CP. All treatments were fed 1.8 kg·hd⁻¹·d⁻¹. Mature cows (n=213) grazed predominantly Tall Fescue pasture with 65 cows in the FP#1 treatment, 80 cows in the C treatment and 68 cows in the FP#2 treatment. Two-year-old cows (n=54) were managed in dry lots and received Johnson Grass hay and a corn silage diet with 18 cows in each of the three treatments. Body condition scores were taken at the start of feed treatment and prior to breeding to evaluate effects of supplementation on body condition. Mature cows received supplementation for 45 d and 2-year-olds received supplementation for 51 d prior to their synchronized periods. Heifers and cows received MGA (.5mg·hd⁻¹·d⁻¹) for 14 d followed by an injection of PG (25 mg Lutalyse®) 19 d after MGA withdrawal. Cows were observed for estrus for 6 days beginning on the day PG was administered. Cows were inseminated 12 hrs. after observed estrus. Data were analyzed using the General Linear Models procedure of SAS. Percentage data were analyzed by Chi square analysis. Estrus response among 2-year-old cows was influenced ($P < .05$) by feed treatment with 94% of FP#1, 44% of C, and 78% of FP#2 responding. Final pregnancy data have not yet been obtained. Although no differences among treatments ($P > .05$) were observed for mature cows that exhibited estrus during the synchronized period, there was a difference ($P = .05$) in first service conception rate for those cows that exhibited estrus (76%-FP#1, 60%-C, 73%-FP#2). These data suggest that postpartum supplementation of fat products to primiparous 2-year-old and mature cows may improve estrous cyclicity and resulting response to estrus synchronization, and enhance conception rate at first service.

Key Words: Fat supplementation, Estrus response, First service conception

942 Additive effects of strategic deworming with fenbendazole, supplementation with bambermycins, and(or) use of TBA-estradiol implants during the grazing phase on grazing-finishing performance of yearling steers. I. Grazing performance. W. K. Rowland*¹, E. G. Johnson¹, and R. T. Brandt, Jr.², ¹*Johnson Research, Parma, ID*, ²*Intervet, Inc., Millsboro, DE.*

Three hundred and twenty English cross-bred, short-yearling steers (265 kg) were used in a 2 x 2 x 2 factorially arranged experiment to evaluate the main effects and interactions of strategic deworming with Safe-Guard® (fenbendazole), Gainpro® (bambermycins) supplementation, and(or) implantation with Revalor-G® (40 mg trenbolone acetate, 8 mg estradiol) on grazing performance, and subsequent feedlot performance and carcass traits. Each of the eight treatment combinations were assigned to each of 5 blocks of contiguous pastures (8 head per pasture group, 40 pasture groups total). Steers grazed 114 d on pastures containing 70-80% native grasses and(or) fescue, and 20-30% legume species (alfalfa or clover). All steers received .91 kg/hd/d of a corn-based supplement. Strategically dewormed steers received a 10% Safe-Guard oral suspension on day 0, and Safe-Guard 1.96% Flaked Meal via the corn supplement on d 28 and 56. Treatment groups receiving Gainpro were fed 20 mg of bambermycins daily. All Safe-Guard treatments provided 5 mg/kg body weight of fenbendazole. There were no two- or three-way interactions ($P > .05$), demonstrating that performance enhancement from strategic deworming with Safe-Guard, supplementation with Gainpro, and implantation with Revalor-G were additive. Strategic deworming with Safe-Guard increased ($P < .0008$) weight gain by 10.0 kg compared to no deworming. Supplementation with Gainpro and implantation with Revalor-G provided an additional 9.1 kg ($P < .0017$) and 17.3 kg ($P < .0001$) of weight gain, respectively. Economic analyses showed that use of a Safe-Guard strategic deworming program, along with Gainpro and Revalor-G, resulted in a net profit that was \$31.31 per head greater than for the negative control steers. A comprehensive pasture management system involving strategic deworming with fenbendazole, bambermycins supplementation, and implantation with Revalor-G provided additive effects to grazing performance and economic return to stocker steers.

Key Words: Fenbendazole, Bambermycins, Trenbolone acetate

943 Additive effects of strategic deworming with fenbendazole, supplementation with bambermycins, and(or) use of TBA-estradiol implants during the grazing phase on grazing-finishing performance of yearling steers. II. Finishing performance and carcass traits. W. K. Rowland*¹, E. G. Johnson¹, R. T. Brandt, Jr.², and W. T. Nichols², ¹*Johnson Research, Parma, ID*, ²*Intervet, Inc., Millsboro, DE.*

A 140-d finishing trial was conducted to measure carryover effects of strategic deworming with Safe-Guard® (SG), supplementation with Gainpro® (GP), and(or) implantation with Revalor-G® (RG) during summer grazing on subsequent feedlot performance, carcass merit, and combined grazing-finishing gain. Pasture treatments were arranged in a 2 x 2 x 2 experiment. Results of the grazing phase of this trial are reported in the first abstract of this series. Pasture groups were gathered at the end of grazing, held overnight, and weighed. There were 40 pens of 8 head each (5 pen replicates per treatment combination) in this study. Feeding, management, and health practices were identical for all treatment groups during the feedlot phase. No two- or three way interactions ($P > .05$) between SG, GP, and RG occurred for feedlot performance or carcass traits in this study. Use of SG on pasture resulted in ($P < .05$) 10.0 kg heavier feedlot final weights, 6.4 kg more carcass weight, .47 units higher dressing percentage, 15 percentage units more Choice carcasses, and fewer dark cutters than non-SG steers. Steers supplemented with GP on pasture numerically maintained weight advantages through the finishing phase, with no effect on feedlot performance or carcass merit. Steers implanted with RG on pasture had ($P < .05$) 5.5% poorer feed conversion, but 15.0 kg heavier final weights and 9.1 kg more hot carcass weight than non-RG steers. Most of the reduction in feed efficiency with RG was explained by heavier initial feedlot weights, using net energy equations. Use of RG on pasture did not affect carcass quality. The effects of SG, GP, and RG on combined grazing-finishing gain were additive, and resulted in an additional 28.6 kg of gain. Economic analyses for the combined grazing-finishing period showed that using SG, GP, and RG together during the pasture phase increased net profit by \$31.58 per head for steers sold on a formula basis, or \$14.86 per head for steers sold live.

Key Words: Fenbendazole, Bambermycins, Trenbolone acetate

944 Computer assisted semen analysis of bovine semen. H. L. Higdon III¹, W. B. Boone¹, J. C. Spitzer², and W. C. Bridges, Jr.², ¹Greenville Hospital System, Greenville, SC, ²Clemson University, Clemson, SC.

Computer assisted semen analyzers (CASA) are used routinely to objectively analyze spermatozoal integrity and ascertain reproductive potential among human subjects. Likewise, semen samples are obtained from yearling beef bulls as part of the standard breeding soundness evaluation (BSE). Our objective was to provide preliminary data generated by an automated semen analyzer [Hamilton-Thorne V10 Integrated Optical Visual System (IVOS), Beverly, MA] on semen collected from yearling beef bulls that were rated satisfactory potential breeders by the Society for Theriogenology 1993 BSE requirements. Data included IVOS spermatozoal parameters obtained at the 2000 Clemson University performance bull test from 49 beef bulls. In brief, three replications from each semen specimen were diluted in 1% BSA:PBS to between 20 to 50 million spermatozoa/mL, vortexed, and loaded into MicroCell™ 20 micron chambers (Conception Technologies, San Diego, CA). A minimum of six fields and 200 spermatozoa were counted for each replication. Slow moving cells were not counted as motile. Mean and standard deviation for ejaculate volume, total spermatozoal concentration and percent motility were 5.3±2.7 mL, 464.8±500.9 million/mL, and 75.3±15.9%, respectively. Mean and standard deviation for IVOS spermatozoal kinematics were as follows: average path velocity (VAP) 123.6±14.0 µm/s; straight line velocity (VSL) 104.8±12.4 µm/s; point-to-point track velocity (VCL) 205.1±28.9 µm/s; amplitude of lateral head displacement (ALH) 7.7±1.5 µm; beat cross frequency (BCF) 35.0±6.6 Hz; straightness (STR) 82.7±5.4%; linearity (LIN) 52.5±6.4%; elongation 41.6±3.8%; head area 13.0±1.8 µm²; rapid motile cells 61.1±16.9%; medium motile cells 14.2±5.8%; slow motile cells 10.1±5.4%; static cells 14.6±12.8%. This study provides preliminary information from which more objective means may be developed to assess reproductive potential among yearling beef bulls.

Key Words: Breeding Soundness Evaluation, Computer Assisted Semen Analysis, Beef Bulls

945 Pregnancy rates in postpartum beef cows after synchronization with GnRH, PGF_{2α}, and MGA. M. L. Borger and W. A. Greene*, *The Ohio State University, Wooster.*

Eighty-eight beef cows were allotted to four similar groups based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by ultrasonography) to compare pregnancy rates (PR) among four synchronization regimens. All four groups received GnRH i.m. on d 0, prostaglandin F_{2α} (PGF_{2α}) i.m. on d 7, GnRH i.m. on d 9 (48 h after PGF_{2α}), and were artificially inseminated 16 h after the d 9 GnRH injection. Groups 1 and 2 were fed melengesterol acetate (MGA) from d 0 to d 6 at a rate of .5 mg/cow/d while Groups 3 and 4 were fed only the base diet. Groups 1 and 3 received 50 µg of GnRH at each injection while Groups 2 and 4 received 100 µg of GnRH each time. Following the synchronization period, repeat breedings were done until d 54. Cows were pregnancy diagnosed by ultrasonography on d 33 and d 77. PR to synchronization (PR-SYNC) and overall PR were similar among all groups (P>.05). PR-SYNC for Groups 1, 2, 3, and 4 were 66.7, 54.6, 50, and 50%. Overall PR for Groups 1, 2, 3, and 4 were 85.7, 77.3, 86.4, and 77.3%. MGA tended to improve (P=.39) PR-SYNC (60.5 vs. 50.5%). PR-SYNC and overall PR were not affected (P>.05) by postpartum cyclicity status at time of synchronization. Beef cows receiving 50 µg of GnRH had similar PR to those receiving 100 µg of GnRH, regardless of the addition of MGA to the ration or postpartum cyclicity status.

946 The influence of vitamin E on immunoglobulins in the serum of cows and calves and colostrum of cows on 1, 2, 7, and 14 days after calving. A.L. Rivard*, T.A. Hoagland, K.E. Govoni, S.A. Zinn, and R.M. Hoffman, *University of Connecticut, Storrs.*

Twenty-five pregnant beef cows, eleven Angus and fourteen Hereford, were randomly allocated within breed to receive Vitamin E (3000 IU) or non-injected controls: injections were given two-month and one-month before parturition. The purpose of this study is to investigate the influence of Vitamin E on the concentration of IgG (IgG1 and IgG2), IgA, and IgM in the blood of cows and calves and in the dam's colostrum. Colostrum was sampled within ten minutes of parturition. Blood was

obtained on the day of calving (d1), the day after (d2), and then once a week for two weeks after calving. The concentration of IgG, IgG1, IgG2, IgA, and IgM was determined by single radial immunodiffusion (VMRD, Inc.). The concentration of IgG1 (1733±55 mg/dl) in the colostrum on d1 was greater (P<.001) than any of the other globulins measured. IgA (814±22 mg/dl) was elevated over (P=0.0008) the concentration of IgG2 (346±8 mg/dl) and IgM (224±67 mg/dl) in colostrum. Pre-parturition Vitamin E treatment did not influence the concentration of any globulins measured in the colostrum. The concentration of IgG (2732±989 mg/dl) was three to ten-fold greater (P<.0001) than the other globulins in cow serum with IgG1 being dominant over IgG2. IgG2 concentration was greater than IgM, which was in turn greater (P<.01) than IgA, which was the least. The concentration of globulins in cow serum varied over days sampled. In calf serum, IgG1 concentration rose from non-detectable to 3616±120 mg/dl by d2. Although increases in calf serum IgA, IgM and IgG2 were observed, they were smaller than those of IgG1. Pre-partum Vitamin E did not influence (P=.6578) calf serum immunoglobulin concentrations. Averaged over all cows and calves, immunoglobulins were greater in cow than calf serum with significant differences (P<.0001) in IgM and IgG2. In conclusion, Vitamin E treatment during late gestation did not alter the remarkable uptake of immunoglobulins, predominantly IgG1, from cow colostrum by the neonatal calf.

Key Words: Calf, Colostrum, Immunology

947 Effects of horn fly (Diptera: Muscidae) control on growth and reproductive performance of Angus and Brangus heifers. W. E. Wyatt*¹ and L. D. Foil², ¹Louisiana State University Agricultural Center, Jeanerette, ²Baton Rouge.

A total of 151 Angus (A) and Brangus (B) heifers (12 and 10 sires) were retained from the 1996 (Y1; 42 and 42) and 1997 (Y2; 32 and 35) calf crops as herd replacements. Prior to the initiation of the breeding season in mid-April, heifers within breed were randomly allotted to one of two treatment herds. In mid-May, a 30% diazinon-10% chlorpyrifos insecticidal ear tag (Warrior®, Y-Tex Corporation, Cody, WY) was placed in each ear of heifers in one herd within each breed (T). Heifers in the remaining herds were not treated for horn fly control (NT) throughout the May to October season. Seasonal mean fly counts per side of cow were 52, 24, 47, and 18 in Y1 and 60, 20, 40, and 14 for Angus and Brangus NT and T herds and were below the presumed economic threshold of 200 flies per side. Heifers calved the following spring at 2 yr of age. Heifer weight and gain data and calving and calf performance data were analyzed as a randomized block design using a generalized linear mixed model procedure. Fixed effects included year, breed, and fly control treatment. Sire within breed was treated as a random effect. Treatment (NT vs T) affected weight at tagging (P<.10; 328 vs 337 kg) and fall weight (P<.05; 376 vs 384 kg). Daily gain from tagging to fall (G) was similar between treatments. Fall weight (389 vs 371 kg) and G (.33 vs .27 kg) were greater (P<.1) for B than for A. Tagging weight differences between A and B were greater in Y2 (326 vs 348 kg) than in Y1 (330 vs 326 kg) (P<.05). Calves born to A cows were born earlier (P<.01) in the year (44 vs 57 d) than those from B, but had lower (P<.01) preweaning ADG (PG; .67 vs .79 kg) and were lighter (P<.01) at weaning (188 vs 210 kg). Calves from NT cows had lower (P<.01) PG (.70 vs .77 kg) and lighter (P<.01) weaning weights (190 vs 208 kg) than calves from T cows. Treatment differences in heifer G and fall weight may be associated with unintentional differences in tagging weight. However, this explanation seems less plausible in terms of calf performance.

Key Words: Horn fly, Angus heifers, Brangus heifers

948 Effect of dietary energy on pubertal development and reproductive traits of Brangus and Simbrah bulls. C. R. Barthle, B. A. Reiling, J. V. Yelich, R. E. Larsen, and J. W. Lemaster, *University of Florida, Gainesville.*

Brangus (n=27) and Simbrah (n=20) bulls (325 d of age, 296 kg) were used in a switchback designed study to evaluate the effect of dietary energy on measures of pubertal development and reproduction in a 112 d feeding trial. Bulls were initially blocked according to breed, age, body weight (BW), sperm concentration, and scrotal circumference (SC) and randomly allotted to either a low (L; 55%) or high (H; 80%) concentrate diet. On d 57 of the experiment, half of the L- and H-energy treatment bulls were randomly reassigned to the opposite dietary treatment (LL, LH, HL, HH). Breeding soundness examinations were conducted

every 28 d, and blood samples were taken at 14 d intervals to measure metabolic and reproductive hormone concentrations. The LL and HH dietary regimes produced the lightest and heaviest ($P < .05$) weight (455 vs 512 kg) bulls at the end of the trial, respectively. Over the entire trial ADG ($P < .07$) of LL, LH, HL and HH bulls were 1.43, 1.74, 1.73 and 1.89 kg/d, respectively. Puberty in bulls was defined as the age in which the ejaculate contained a total of 500 million sperm with a minimum progressive motility of 10%. No breed or treatment effects were detected for age or physiological parameters of puberty. Bulls reached puberty at an average age of 373 ± 7 d, BW of 391 ± 12 kg, and a SC of $30.74 \pm .66$ cm. Over time, SC (25.7 vs 34.5 cm), semen volume (3.6 vs 9.1 ml), total sperm (35.9 vs 1356.8×10^6), percentage of normal sperm (30.7 vs 68.4%), and gross (30.5 vs 49.9%) and progressive (22.8 vs 38.2%) sperm motility increased ($P < .05$) while the percentage of proximal droplet abnormalities decreased ($P < .01$; 30.5 vs 9.5%). In conclusion, dietary energy did not affect any of the reproductive parameters measured.

Key Words: Bulls, Reproduction, Energy

949 The effect of Angus sires selected for growth or maternal traits: Preweaning and yearling reproduction traits. J. B. Barber*, H. D. Ritchie, D. R. Hawkins, B. D. Banks, S. R. Rust, and D. Neilsen, *Michigan State University, East, Lansing, MI.*

Angus sires selected for either growth (GS) or maternal (MS) traits were mated to commercial cows to investigate preweaning and reproduction traits. Seventeen GS sires were selected on yearling weight expected progeny differences (EPD) from the National Cattle Evaluation program, with a mean percentile of 99 and a minimum accuracy of .60 in the year in which they were selected. Twenty MS sires were selected on milk and birth weight EPD, with mean percentiles above 98 and 80, respectively, and minimum accuracy of .60 for each trait. Data were pooled across 5 yr and analyzed within sex for steers and heifers. Steer calves ($n=348$) sired by GS had heavier ($P < .05$) birth weights (43.8 vs. 40.2 kg), heavier ($P < .05$) adjusted 205-d weights (331 vs. 293 kg), and larger ($P < .05$) weaning frame scores (5.8 vs. 5.4), on a 1 to 9 scale) than steers sired by MS. There was no difference in calving ease score as a trait of the calf. Heifer calves ($n=324$) sired by GS had heavier ($P < .05$) birth weights (41.2 vs. 37.9 kg), heavier adjusted 205-d weights (274 vs. 266 kg), and larger ($P < .05$) weaning frame scores (6.0 vs. 5.7) than those sired by MS. Yearling heifers retained ($n=280$) were evaluated for reproductive traits prior to their first breeding season. Females sired by GS had heavier ($P < .05$) adjusted yearling weights (381 vs. 369), were larger ($P < .05$) framed (6.0 vs. 5.7) and had larger adjusted pelvic areas (202 vs. 194 cm²) than those sired by MS. There were no differences between GS- and MS-sired heifers in yearling condition score, or reproductive tract score. Steers sired by bulls selected for growth had heavier birth and weaning weights and larger frame scores than those sired by bulls selected for maternal traits. Heifers sired by growth bulls had heavier birth, weaning, and yearling weights, larger frame scores, and pelvic areas than heifers sired by maternal bulls, with no differences in condition or reproductive tract scores.

Key Words: Beef cattle, Reproduction, Maternal

950 The effect of Angus sires selected for growth or maternal traits: Feedlot performance and beef characteristics. J. B. Barber*, H. D. Ritchie, D. R. Hawkins, B. D. Banks, S. R. Rust, and D. Neilsen, *Michigan State University, East Lansing.*

Three-hundred-forty-eight Angus-sired crossbred steers were used to evaluate feedlot performance and carcass characteristics of calves by growth or maternal sires (GS or MS). Growth sires were selected on yearling weight expected progeny differences (EPD) from the National Cattle Evaluation program, with a mean percentile of 99 and a minimum accuracy of .60 in the year in which they were selected. Maternal sires were selected on milk and birth weight EPD, with mean percentiles above 98 and 80, respectively, and minimum accuracy of .60 for each trait. Data were pooled across 5 yr and analyzed, after weaning, steers were finished in confinement and allocated to pens by weight and group. Initial weight was greater ($P < .05$) for GS calves than MS calves (277 vs. 268 kg). Steers were slaughtered and carcass characteristics were measured 24 h post-slaughter. Final weight and hot carcass weight was heavier ($P < .05$) for GS than MS steers (555 vs. 535 kg) and (334 vs. 321 kg), respectively. Steers sired by GS also had greater ($P < .05$) frame scores (6.0 vs. 5.5), larger ($P < .05$) rib eye area (1.91 vs. 1.84 cm²), and higher ($P < .05$) marbling score (5.8 vs. 5.6). No differences were

found between sire groups for external fat; kidney, pelvic, and heart fat; or yield grade. Selection for growth versus maternal traits, using sire EPD, increased hot carcass weight, rib eye area, and marbling score.

Key Words: Beef cattle, Carcass, Growth

951 Growing and finishing performance of calf-fed, short- and long-yearling steers. R. D. Sainz*, D. J. Kominek, and M. Sween, *University of California, Davis.*

Sixty Angus-Hereford steers were allocated at weaning (May 1997) to three groups. Calf-fed (CF) steers were sent to the UCD feedlot immediately, short-yearlings (SY) remained on irrigated pasture until Sept. 1997, then sent to the feedlot, and long yearlings (LY) remained on irrigated pasture until Sept. 1997, then on native range until May 1998, then sent to the feedlot. All steers were fed on a high-energy corn-based ration until average ultrasound backfat for the group reached 12.7 mm. Days on feed were 192, 114 and 83 for CF, SY and LY, respectively. During the first summer grazing period, SY and LY gained 0.699 and 0.700 kg/d (SD 0.099), respectively. LY lost 0.055 ± 0.136 kg/d during the subsequent fall and winter, then gained 1.107 ± 0.158 kg/d during the spring. In the feedlot, SY gained more rapidly than CF and LY, which were similar (1.424, 1.122 and 1.219 kg/d, respectively; $P < 0.001$). Pen average DM intakes in the feedlot were 7.97, 9.00 and 12.34 kg/d for CF, SY and LY, respectively. This resulted in gain:feed (DM basis) and feed costs of gain (\$/kg) of 0.140 and 0.80, 0.158 and 0.55, and 0.099 and 1.41, respectively. Short yearlings were more efficient than calf-fed steers, and had much lower costs of production. In this study, long yearlings were very inefficient in the feedlot, contrary to expectations. The reasons for this are unclear, but may include their very rapid previous gains on spring pasture, and also the fact that they entered the feedlot at 435 kg and thus were in a fattening phase.

Key Words: Grazing, Finishing, Beef cattle

952 Relationship between carcass and reproductive traits in Angus heifers. J.A. Minick*¹, D.E. Wilson¹, G.H. Rouse¹, A. Hassen¹, M. Pence², and R. Sealock¹, ¹Iowa State University, Ames, ²University of Georgia, Athens.

Carcass and reproductive data including scan weight (WT), ribeye area (REA), rump fat (RUMP), 12-13th rib fat (RIB), and percentage intramuscular fat (PFAT) at 268, 303, 370 and 405-d; reproductive tract score (RTS) at 344-d; pregnancy status (PREG) after the breeding season; and number of services to conception of AI bred heifers were collected on 180 1998-born Angus heifers to determine the relationship between these traits. RTS ranged from one, a non-cycling tract, to five, a cycling tract as indicated by a corpus luteum. For further analysis, a cycling (CY) score was assigned based on the RTS (4, 5 vs. 1-3). Data were analyzed by the general linear model of SAS. Within animal regressions using linear and quadratic effects of age were fitted to each of the carcass traits. These were used to adjust the carcass data back to the age at which each heifer was evaluated for RTS, and to a 395-d endpoint, which is the average age for carcass ultrasound scanning of Angus heifers in the industry. All carcass measurements at each scan and adjusted age were compared to RTS, PREG and CY. Chi-square tests were performed between the categorical variables of RTS, PREG, CY and number of services to conception. There was no relationship between RTS and any of the measurements of RIB, REA or PFAT ($P > .10$). Heifers with higher RTS tended to be heavier at 405-d and to have more rump fat at 405-d. Heavier heifers and heifers with more rump fat had higher RTS when they were adjusted to 395-d by both models ($P < .05$). There was no relationship between PREG and any of the carcass variables analyzed ($P > .10$). There was no relationship between CY and any measures of RUMP, RIB or PFAT. Heifers that were cycling tended to be heavier at 405-d and have larger REA at 370 and 405-d, and at 395-d adjusted by both models ($P < .10$). Chi-square tests showed there was no relationship between RTS, PREG and number of services ($P > .10$). Heavier heifers that are farther along in their growth and development, as evidenced by increased amounts of rump fat, are more likely to have higher RTS at approximately one year of age.

Key Words: Beef, Reproduction, Carcass

953 Body weight changes in stocker cattle during the initial grazing period on winter wheat pastures. W. A. Phillips*¹, S. W. Coleman², and M.A. Brown¹, ¹USDA-ARS El Reno, OK, ²USDA-ARS Brooksville, FL.

Each year millions of stocker calves are used to graze winter wheat pasture in the Southern Great Plains. Wheat forage is a novel diet to which these stockers are not accustomed. The objective of this experiment was to determine body weight changes that occur in stockers calves as they adjust to winter wheat pasture. Forty crossbred spring born calves (mean BW=262kg) reared at the Grazinglands Research Laboratory were blocked by sex, breed and BW after weaning in the fall. Within each block calves were randomly assigned to one of four treatment groups. All four groups were limit fed a mixed diet with ad libitum access to grass hay for a 14-day training period. Nutrient density and quantity of diet fed was designed to promote an ADG of 0.8 kg. During the training period calves in Groups 1 and 2 (INTENSIVE) were weighed every 2 to 3 d, while the calves in Groups 3 and 4 (EXTENSIVE) were only weighed at the beginning and end of the period. At the end of the training period (day 14), the calves in Groups 1 and 3 were moved to winter wheat pastures. The remaining calves were left in dry lot without a change in diet. From day 14 through day 42, calves in the INTENSIVE groups were weighed 11 times while the calves in the EXTENSIVE groups were weighed only twice (d 29 and 42). During the training period, calves weighed more frequently (INTENSIVE) had lower (P=.03) ADG than calves weighed less frequently (0.87 vs 1.24 kg). Weighing frequency had no effect (P>.10) on weight gain during the 28-d grazing period, but calves placed on wheat pasture lost 6.9 kg of BW during the first 15 d of grazing as compared to a positive gain of 16.2 kg by calves that remained in dry lot. During the second half of the grazing season, calves on wheat gained 20.8 kg, while the calves in dry lot gained 13.2 kg. However, over the entire 28-d grazing period, calves on wheat had a lower (p<.05) ADG than the calves in dry lot (0.49 vs 1.03). From these data we conclude that calves placed on wheat pasture for the first time need 14 to 21 d to adapt to the new diet and begin to make positive weight gains.

Key Words: Wheat pasture, Steers, Stocker

954 Simulated effects of heifer replacement strategies on production and income from beef cattle production in Virginia. J. H. Schick*¹ and W. D. Hohenboken², ¹Case Western Reserve University, ²Virginia Tech, Blacksburg.

The objective of this study was to utilize the Virginia Beef Cattle Simulation Model, a management decision aid developed for the mid-Atlantic region, to predict financial and production impacts of different heifer replacement strategies on a cow/calf operation retaining weaned calves in an 80-d forage-based stocker program. The base herd, located in the mountain region of Virginia, had 115 crossbred Angus females. Replacement strategies included: 1) selecting heifers from within the herd, 2) purchasing heifers to grow out and breed, and 3) purchasing bred heifers to replace nonpregnant cows 60 d after the end of the breeding season combined with either A) purchasing nonpregnant heifers or B) selecting them from within the herd at all other times to maintain herd size. Spring and fall calving seasons were simulated. Each of the eight possible management combinations was simulated 10 times with data captured for 3 yr. Systems that replaced culled cows with nonpregnant heifers purchased at market value or selected from within the herd were financially superior to systems that bought pregnant replacements (P < .01). Under each replacement strategy, retaining calves in a forage-based stocker program enhanced profits (P < .01) compared to the same systems but with calves sold at weaning. When calves were retained in a stocker program, total net income from spring vs. fall calving systems was similar (P > .05). Although higher prices received for fall-born calves sold in the spring than for spring-born calves sold in the fall magnified replacement policy effects, purchasing bred heifers was not predicted to be a profitable strategy for either calving season. Because of the small financial differences predicted between selection and purchase of replacement heifers, producers could use the strategy that most conveniently provided them with the genetic type of heifer most suitable to profitable and sustainable production.

Key Words: Replacement Heifers, Beef Cattle, Simulation

955 Effect of a stair-stepped growth regimen during gestation on performance of beef heifers - prepartum growth performance. W.W. Poland*¹, K.A. Ringwall¹, M. Encinias², L.J. Tisor¹, G. Ottmar¹, J.W. Schroeder², and C.S. Park², ¹North Dakota State University, Dickinson, ²North Dakota State University, Fargo.

A stair-step nutrition and feeding regimen has been shown to produce compensatory responses in growth efficiency and increase subsequent lactation performance. Objectives of this study were to determine the effect on growth performance and lactation potential of beef heifers reared on a simplified stair-step growth regimen imposed during gestation. Lactation performance is reported in a companion abstract. Twenty pregnant beef heifers (463±37 kg; 6.7±.3 body condition score [BCS]) were blocked by breeding sire and assigned to either a constant (C) or a stair-step (S) growth regimen for 18 wk immediately prepartum. Animals assigned to C were fed a diet designed to meet the nutrient requirements of heifers gaining .45 kg/d throughout the feeding period, while S heifers were fed an energy-restricted diet for 9 wk. Metabolizable energy concentration (ME) of the restricted diet was similar to C, however dry matter intake (DMI) was to be limited to 70% of C. Protein concentration (CP) was increased in the restricted diet to allow similar daily protein intakes between treatments. Following the restriction phase, S heifers were given ad libitum access to a high energy (130% ME and 100% CP of C) diet to allow compensatory growth for 9 wk. Subsequently, all heifers were managed similarly through weaning. Average daily gain (ADG); .51 vs .17 kg/d for C and S, respectively; P<.10), BCS (6.5 vs 6.0, P<.15) and dry matter intake (DMI; 10.8 vs 8.2 kg/d, P<.01), but not growth efficiency (GE, gain/feed;.047 vs .021, P=.18), were reduced in the restricted phase of S. Conversely, ADG (-.14 vs 1.36 kg/d, P<.01), DMI (8.0 vs 8.8 kg/d; P<.05), BCS (6.2 vs 7.0, P<.06) and GE (-.017 vs .153; P<.01) were increased in the compensating phase of S. Over the entire feeding period, ADG (.20 vs .73 kg/d; P<.01) and GE (.022 vs .086; P<.01) were increased, whereas DMI (9.3 vs 8.4 kg/d; P<.05) was reduced, by the experimental regimen. These results indicate that beef heifers reared on a stair-step growth regimen during gestation display compensatory responses in average daily gain and growth efficiency.

Key Words: Stair-step, Beef Heifer, Gestation

956 Effect of a stair-stepped growth regimen during gestation on performance of beef heifers - postpartum lactation and calf performance. W.W. Poland*¹, K.A. Ringwall¹, M. Encinias², L.J. Tisor¹, G. Ottmar¹, J.W. Schroeder², and C.S. Park², ¹North Dakota State University, Dickinson, ²North Dakota State University, Fargo.

A stair-step growth regimen during hormone-sensitive growth phases prior to first parturition can affect mammary development and subsequent performance. Objective of this study were to determine the effect on growth performance and lactation potential of beef heifers reared on a simplified stair-step growth regimen imposed during gestation. Prepartum growth performance is reported in a companion abstract. Twenty gestating beef heifers were blocked by breeding sire and assigned to either a constant (C) or a stair-step (S; managed for a slow followed by a rapid growth rate) growth regimen for 18 wk immediately prepartum. Following the experimental phase, all heifers were managed similarly. Immediately prior to calving, C heifers had lower BW (492.4 vs 546.1 kg for C and S, respectively; P<.01) and body condition scores (BCS; 6.2 vs 7.0, P=.06) than S heifers. Calves from S heifers were born approximately 5 d earlier (P=.01), however birth weights (37.5 vs 36.7 kg; P=.61) did not differ. Three calves died at calving (1 C and 2 S), one (S) at 2 d of age and one (S) at 110 d of age. Neither milk production at 40 d postpartum (6.7 vs 6.3 kg/d; P=.72) nor milk composition (P>.33) in heifers with calves were affected by gestational treatment. Heifers and calves were moved to spring pastures at approximately 79 d postpartum. Heifers with calves had similar BW (458.8 vs 486.5 kg; P=.14) and BCS (6.0 vs 6.2; P=.32) at pasture turnout. Calves from S heifers (76.8 vs 84.7 kg; P<.05) were heavier, however average daily gains from birth to pasture turnout (1.00 vs 1.04 kg/d; P=.41) were not different. Calves were weaned at 234 d of age. Body weight (503.8 vs 536.9 kg; P=.11) and BCS (5.7 vs 5.9; P=.61) of heifers with calves were not different at weaning. At weaning, actual calf weight (264.3 vs 268.8 kg; P=.66), average daily gain (.98 vs .98 kg/d; P=.98) or weight per day of age (1.14 vs 1.13 kg/d; P=.93) were also not different due to gestational treatment. These data would suggest that a stair-step growth regimen

during gestation resulted in earlier calving dates, but did not affect calf birth weight, milk production or subsequent calf growth in beef heifers.

Key Words: Stair-step, Beef Heifer, Lactation

957 Feeding supplemental fat to mature cows. R. A. Bellows^{*1}, E. E. Grings¹, D. A. Phelps¹, S. E. Bellows¹, T. W. Geary¹, and D. D. Simms², ¹USDA-ARS and Montana Agric. Exp. Sta., Miles City, MT, ²Consolidated Nutrition, Omaha, NE.

Multiparous, crossbred cows (n = 140; ages 3-8 yr) grazing winter range forage and calving in Feb or April received one of three supplements during late gestation: 1, C, Control 1.4 kg pelleted alfalfa daily; 2, T, self-fed fat supplement in 102 kg plastic tubs; 3, B, fat supplement fed every-other-day in 15 kg compressed blocks. Supplement compositions (DM basis) were: C, 22.0% protein (P), 1.5% fat (F); T, 21.9% P, 25.9% F; B, 22.4% P, 14.2% F; fat was from dam safflower seeds. All cows received 10 kg hay (20% P, 1.5% F) daily during severe weather. Cow weights and condition scores were obtained during the study; estrous cyclicity at begin breeding was determined by P4 in blood; breeding was synchronized with injected PG given 5 d after begin breeding; pregnancy was based on ultrasound. Calf data included: birth weight, calving ease (CE), sex, and weaning weight. Data were analyzed by SAS-GLM and Chi square. Supplement feeding averaged 77.5 ± 7.1 d prepartum. Effects of delivery system and fat on dam precalving weights or condition scores and calf birth weight or CE scores were nonsignificant. Supplement consumption in B cows was uniform, but consumption by T cows varied from 0 to 4.5 kg (estimated) daily. T cows had higher post calving (P=0.09) and prebreeding (P<0.05) condition scores than C or B cows. C cows had higher (P=0.06) prebreeding P4 concentrations (1.5, 1.2, and 0.8 ng/mL, C, T, and B, resp.), but estrous cyclicity was not affected by fat or season. Cyclicity at begin breeding (P=0.08) and final pregnancy % (P=0.06) were affected by the calving season x delivery group interaction which suggested cows calving in Feb followed by limited forage postpartum benefitted from fat supplement, but cows calving in April did not. Fat supplement increased calf weaning weight 4 kg (P>0.20). We conclude effects of feeding fat during gestation are modified by forage availability postpartum and response in multiparous cows may differ from that in primiparous heifers.

Key Words: Cattle, Fat Supplement, Prepartum

958 Improving the quality and value of market cows and bulls. D.L. Roeber^{*}, K.E. Belk, J.D. Tatum, T.G. Field, J.A. Scanga, and G.C. Smith, Colorado State University, Fort Collins.

The 1999 National Market Cow and Bull Quality Audit was comprised of face-to-face interviews with industry representatives (n = 49), in-plant evaluations of cattle/carcasses in holding pens (n = 3,969), on harvest floors (n = 5,679) and in carcass coolers (n = 4,378), and a Strategy Workshop. Face-to-face interview concerns related to price discovery for carcasses following excessive trimming due to bruises and arthritic joints, along with too frequent incidence of antibiotic residues and birdshot. In-plant audits revealed that 88.9%, 10.3% and 88.2% of cow carcasses and 18.9%, 21.2% and 52.9% of bull carcasses had inadequate muscling, arthritic joints and at least one bruise, respectively; all of which resulted in greater (P < .05) losses than the same defects in a similar audit in 1994. Also, 14.5% and 30.8% of cow carcasses and 6.9% and 5.9% of bull carcasses had excess external fat and yellow-colored external fat, respectively; which was an improvement (P < .05) to 1994 results. In aggregate, 24.1%, 19.2%, 7.2%, 6.7%, 9.5% and 1.1% of livers, tripe, hearts, heads, tongues and whole cattle/carcasses, respectively, were condemned and 60.6%, 2.4% and 46.5% of cattle had hide damage from latent defects, insect damage and brands, respectively. Condemnation rates were generally lower (P < .05), but tongue condemnations and branded hides were higher (P < .05) than in 1994. The four tactics to reduce the incidence of defects that emerged in the Strategy Workshop included recognize and maximize the value of your market cows/bulls, be proactive to ensure the safety and integrity of your product, use appropriate management and handling practices to prevent quality defects, and closely monitor herd health and market cull cattle at the appropriate time to avoid severe quality defects. A "Quality Assurance Marketing Code of Ethics" to facilitate implementation of these tactics was proposed. Producers should promote value in cows/bulls by managing to minimize quality defects, monitoring the health and condition and marketing in a timely manner. Using these

techniques, producers might have recaptured \$13.82, \$27.50 and \$27.50, respectively, for each cow/bull harvested in 1999.

Key Words: Quality, Cows, Bulls

959 Comparing economic return to a group of co-operating beef producers for selling calves near weaning versus retaining ownership for a post-weaning growing period. R. L. Larson^{*}, V. L. Pierce, and K. C. Olson, University of Missouri, Columbia.

Two groups of producers in Missouri commingled their calves after weaning for a post-weaning growing period. A group in Monroe City commingled spring-born calves on December 1 and marketed the calves in late January. A group in West Plains commingled fall-born calves on June 7 and marketed the calves in late August. Predicted return to management of the cowherd at the time of commingling shortly after weaning was estimated by using the weekly average calf prices from local livestock markets as reported by the Missouri Department of Agriculture. The return to management of the cowherd at the time of sale was determined by subtracting the expenses of the growing period from the gross receipts. The return at the time of sale was positively correlated most strongly with body weight at the time of sale for both the Monroe City cattle (r²=0.963; P<0.0001) and the West Plains cattle (r²=0.701; P<0.0001). Return at sale was also strongly positively correlated with body weight at arrival for both the Monroe City cattle (r²=0.795; P<0.0001) and for the West Plains cattle (r²=0.688; P<0.0001). Return at sale was moderately positively correlated with ADG for the Monroe City cattle (r²=0.515; P<0.0001) and slightly positively correlated with ADG for the West Plains cattle (r²=0.261; P<0.001). ADG was not correlated with arrival body weight in either group (P>0.1). T-test comparisons of cattle that had a greater return after being grown post-weaning versus those that had a greater return if sold shortly after weaning showed that ADG post-weaning was greater in cattle that benefited economically from the growing period than those that did not benefit (P<0.001). Body weight at sale was higher for cattle that benefited from the growing period (P<0.01). Body weight at the start of the post-weaning growing phase tended to be higher for cattle that did not benefit economically from the growing period versus those that benefited (P<0.1) for the West Plains calves, but was not different for the Monroe City calves.

Key Words: Post-weaning growth, ADG

960 Evaluation of a simulated fenceless livestock control system. S. B. Markus^{*1}, D. W. Bailey², and M. Price³, ¹Alberta Agriculture Food and Rural Development, ²Montana State University, Bozeman, ³University of Alberta, Edmonton.

New technology may allow development of fenceless livestock control systems (FLCS). Previous work suggests cattle movements can be controlled without physical barriers in both drylot and pasture situations. A trial was conducted using a simulated FLCS consisting of Tri-tronics[®] training units capable of emitting electric shock (5600 V) to the muzzle of an animal by remote control under a rotational grazing scenario. The objective of this study was to determine if visual and auditory cues increased the ability of cattle to identify and respond to a FLCS boundary. Thirty two yearling beef heifers were randomly allocated to 4 treatments in a randomized block design: control (FLCS with no additional cues), audio (FLCS with tone 1.5 m from boundary), visual (FLCS with ground flags 5 m apart along boundary), and audio and visual (FLCS with both tone and flags). In all treatments, cattle received mild shocks as they crossed the boundary and remained in the exclusion zone of a 0.5 ha pasture. Attempts to enter the exclusion zone and the number of shocks received during a 1 h observation period were similar (P>0.05) for all treatments. However, behavior varied (P<0.01) among days for all variables. On day 1, 34% of the animals entered the exclusion area, while on days 2 and 3 less than 1% entered. Cattle were first exposed to FLCS in a 20 x 30 m pen for 2 d before the study, however these results suggest training should occur under pasture conditions. Addition of visual and or audio cues did not affect the ability of cattle to detect and avoid the exclusion zone. Cattle appeared to associate the FLCS boundary with a patch rather than a widespread area or linear boundary. Social interactions were evident, as heifers appeared to follow lead animals. Cattle movements can be controlled without visual barriers using FLCS, provided they are properly trained.

Key Words: Cattle, Behavior

961 Evaluation of a simulated livestock control system under equipment failure. S.B. Markus^{*1}, D.W. Bailey², and M Price³, ¹Alberta Agriculture Food and Rural Development, ²Montana State University, Bozeman, ³University of Alberta, Edmonton.

New technology may allow for the development of livestock fencing systems without physical barriers. Previous work suggests cattle movements can be controlled with fenceless livestock control systems (FLCS) if properly trained. Social interactions among herd mates have been observed. Thus, a study was conducted to determine the influence of dominant animals on herd movements under a simulated equipment failure. A trial was conducted using a simulated FLCS consisting of Tritronics[®] training units capable of emitting electric shock (5600 V) to the muzzle of an animal by remote control under a rotational grazing scenario. Twelve beef heifers were randomly allocated to 3 treatments in a randomized block design: control (all 4 animals had functional FLCS units), one-off (1 of 4 animals had a non-functional FLCS unit), and two-off (2 of 4 animals had non-functional FLCS units). Animals with non-functional FLCS units were the most dominant in their treatment group based on social dominance ratings conducted before the study. Cattle were observed grazing in half of a 0.5 ha pasture for 1 h on 3 consecutive days. Heifers with functional FLCS units in each treatment did not differ ($P > 0.05$) in the number of attempts to enter the exclusion zone or in the number of shocks received. Although social interactions were evident (heifers followed lead animals), adverse stimuli (mild shock) from the FLCS units had more influence on cattle behavior than being separated from dominant animals. Cattle with functional FLCS units were frequently observed to graze near the lead animals. Cattle movements can be controlled without visual barriers using FLCS. If equipment fails on a few individual animals, control of the herd can be maintained.

Key Words: Cattle, Behavior

962 The next dairy: A case study on factors to consider when establishing a new dairy at a remote site. N.R. St-Pierre^{*1}, L.R. Jones², and J.A. Pennington³, ¹The Ohio State University, Columbus, ²FARME Institute, Homer, NY, ³University of Arkansas, Little Rock.

Changes in the marketing and milk pricing policies of US milk are encouraging producers to view the US milk production on a more global basis than what has been traditional. Many producers are actively looking at potential sites for building a new dairy in States that are far removed from their State of residence. This case study, based on the experience of a young New York producer along with his investment partners, provides a detailed description and analysis of the many factors involved in the site selection and the decision to build a new dairy: (1) societal and environmental considerations, (2) facilities and farmstead layout, (3) agronomic and natural resources considerations, and (4) production and financial risks. Participants are then asked to make a recommendation to the producer.

Key Words: Case Study, Site Selection, Dairy Relocation

963 Reproductive trends among Southeastern dairy herds. S.P. Washburn^{*1}, C.H. Brown¹, B.T. McDaniel¹, and S.L. White¹, ¹North Carolina State University, Raleigh.

Dairy records were examined to determine trends in the Southeastern region (VA, NC, SC, GA, FL, KY, AL, and MS) from 1974 to 1999. Year-end DHI herd summary data were from Dairy Records Management Services in Raleigh, N.C. Herds with data for at least 25 of 26 years were used. Herds with services per conception < 1.4 were deleted due to the likelihood of unrecorded natural matings. Data were further processed by computing 4-year averages for the first (1974-1977) and last (1996-1999) periods and 3-year averages for other intervals. For statistical analyses, 2 Ayrshire, 1 Brown Swiss, and 2 Guernsey herds were grouped. Separate groups included 316 Holstein or 17 Jersey herds. Days open and services per conception averages by breed group and time period are shown below. Increases in herd size, milk, fat, days open, and services per conception across time were evident. Regression analyses indicated positive linear and quadratic effects of time on increasing days open (all groups) and positive linear and quadratic effects of time on increasing services per conception for Holsteins (only quadratic for

Jerseys). Services per conception tended higher with higher milk production in all breed groups but days open were lower in higher producing Holstein herds. Effects of herd size were small. Beginning in the late 1980's to early 1990's, services per conception and days open increased at a greater rate than in earlier years and such trends are of concern.

Time Period	Holsteins		Jerseys		Ayr., Swiss,Guern.	
	Days Open	Services per Conc	Days Open	Services per Conc	Days Open	Services per Conc
1974-1977	127	1.85	127	1.81	126	1.97
1978-1980	127	1.98	127	1.90	129	2.12
1981-1983	128	2.07	123	2.00	127	2.33
1984-1986	129	2.10	119	1.94	133	2.18
1987-1989	134	2.22	122	2.24	130	2.24
1990-1992	139	2.59	126	2.53	140	2.63
1993-1995	147	2.96	136	2.96	143	3.04
1996-1999	162	3.12	147	3.08	173	3.08

Key Words: Dairy, Reproduction, Fertility

964 Monitoring estrus detection efficiency in dairy cattle using cusum and Shewhart charts. A. de Vries^{*}, G. R. Steuernagel, and B. J. Conlin, *University of Minnesota, St. Paul.*

Objective of the study was to compare days to signal using binomial cumulative sum (cusum) and Shewhart (Xbar and I) charts of first service interval (days between calving and first service) and service index (number of services / number of eligible cow days) for a persistent decline in estrus detection efficiency. Cusum, Xbar and I charts are statistical process control charts which are used to monitor, control, evaluate, and analyse a process. Their design and applicability in dairy herd management has not yet been fully explored. Design of these charts depends on an acceptable type I / type II error ratio and the probability density function of the variable of interest. Weekly first service interval (FS) was charted with an Xbar chart and a cusum chart. Service index (SI) was charted with an I chart and a cusum chart. All charts were designed for a type I error rate of 1 in 360 days. A stochastic dynamic dairy herd simulation model was developed which simulates individual cows from day to day. A steady-state herd of 100 dairy cows was created. Default probability (Pr) of estrus detection was 0.45. Three scenarios were simulated for 200 runs for 3000 days each: A: no change in Pr (estrus detection), B: Pr(estrus detection) = 0.35 after day 500, and C: Pr(estrus detection) = 0.35 during the weekend after day 500. Data from the first 500 days were used to calculate control limits. Estimation of days to signal started at day 501. Days to signal for scenario A were: 375 (FS, Xbar), 217 (FS, cusum), > 2500 (SI, I), and 210 (SI, cusum). Days to signal for scenario B were: 277 (FS, Xbar), 84 (FS, cusum), > 2500 (SI, I), and 70 (SI, cusum). Days to signal for scenario C were: 291 (FS, Xbar), 151 (FS, cusum), > 2500 (SI, I), and 137 (SI, cusum). We concluded from scenario A results that the probability density functions of the charted variables need to be better characterized as the estimated days to signal differed significantly from the design for 360 days. SI sample size for I chart was too small to detect the decline. As expected, cusum charts signalled sooner than Xbar or I charts for a persistent decline in estrus detection efficiency.

Key Words: Shewhart, Cumulative sum, Estrus detection

965 Comparison of AI pregnancy rates in dairy cattle by order of preparation of insemination straws. Greg Goodell^{*}, *DUO Dairy Research Facility, Loveland, CO.*

This trial was conducted to evaluate the pregnancy rate by straw of an AI technician preparing more than 1 straw of semen at a time. It has become commonplace for some AI technicians on commercial dairies to prepare 2, 3 or 4 straws of semen for breeding simultaneously and then walk to the cows and breed the cows. This practice has increased dramatically on large dairies where there may be many cows to breed each morning or in facilities where AI materials and tools are not easily accessible from the cow pens. This trial was a retrospective study conducted on a 2500 cow dairy in Northern Colorado. All breedings being reported for this data were a result of a timed AI exposure to the cows through the utilization of a typical Ovsync program. Breeding results from one technician were analyzed for one hundred eighty cows. Regardless of the order in which the straws were applied to the cow they were all prepared together. They were thawed for 30-60 seconds in a thaw box where the temperature was maintained at 96 degrees Fahrenheit and promptly inserted into the insemination rod using standard AI

practices. The cow receiving the first straw of semen was labeled straw one, the cow inseminated with the second straw was labeled straw 2 and so on. Sixty-two cows were inseminated with the first straw, fifty-eight cows were inseminated with the second straw, fifty-three cows were inseminated with the third straw and seven cows were inseminated with the fourth straw. Pregnancy rates from the first straw to the fourth straw were 48.4%, 41.4%, 17.0% and 14.3% respectively. Since there were only 7 cows inseminated with a fourth straw the data was grouped with the data from the third straw for statistical analysis. Statistical analysis using oneway ANOVA yielded no statistical difference between the first and second straw but was highly statistically significant when compared to the third ($p < .0009$). The conclusion of this study was that cows bred with the third or fourth straw yielded much lower pregnancy rates than those bred with the first or second straw. The straw number is an indirect measure of time that the semen is exposed to the environment and emphasizes the fact that preparing more than 2 straws using the recommend methods for artificial insemination will result in lower pregnancy rates.

Key Words: reproduction, pregnancy rate by straw, ovsync

966 Effects of performance and physiological characteristics of dairy heifers on first lactation yield and lifetime performance. M.L. Miller* and M.A. Faust, *Iowa State University, Ames.*

Data were heifer measures and yields for >5,100 Holstein cows in 121 herds. Heifer data included birth month and year, weights, breeding and calving ages, and sire Predicted Transmitting Ability (PTA) for milk, fat, protein and somatic cell score during 4 age categories (birth to: calving, 8, 11, and 65 wk). Health data were indicator variables for occurrence during each age category of scours, respiratory, digestive, reproductive, lame, injury and other health events. Separate models were run for the 2 yield response variables by using independent variables from the 4 age category subsets; thus a total of 8 different models were evaluated. Important independent variables from earlier age subsets were included in analyses for subsequent sets. Response variables were milk per day of calving interval for first lactation and milk per day of life from 24 mo. Overall, regression coefficients for a given independent variable were similar when the variable was included in analyses for different age subsets. Birth weights were important ($P < .01$) for both yield traits; coefficients for first lactation and lifetime yield, respectively ranged from .95 to 1.02 and .09 to .95 \pm 142 kg/kg. Coefficient for calving weight was important for lifetime yield only, but was smaller than birth weight coefficients for this variable (.055 \pm 0.008 kg/kg). Twins produced less first lactation and lifetime milk - estimates ranged from 6.78 to 24.4 \pm 5.07 kg. for single births and 4.24 to 19.59 \pm 17.41 for twins. Incidence of "other" health events was associated with less milk for first lactation (b-value = -7.86 to -10.9 \pm 3.03). However, health and twinning information were available for 3% of animals only. Sire PTA for somatic cell score was important for first lactation only, and indicated that daughters of sires with lowest score produced the most milk (-1.56 \pm .3217 score/kg). Sire PTAs for milk were favorable; daughters of highest PTA milk sires produced the most milk, regardless of when PTAs were available for the heifer. Measuring traits such as birth weight in conjunction with genetic merit on heifers may be informative for culling future low producing cows.

Key Words: Milk-Production, Heifers, Prediction

967 Prepartum milking of Holstein heifers: III. Effects on lactation measures of production, reproduction and udder health. J.F. Kearney*¹, M.M. Schutz¹, S.D. Eicher², and X. Li¹, ¹Purdue University, West Lafayette, IN, ²USDA-ARS, West Lafayette, IN.

Several studies have looked at the effects of prepartum milking on heifers at time of calving. However, recent studies have not considered effects of prepartum milking on production, reproduction, and udder health over the entire lactation. The objective of this project was to investigate the effects of parlor exposure and pre-milking on behavior, production, and health parameters. Effects on Mature Equivalent 305d records of milk (MEM), fat (MEF) and protein (MEP), days to first service, days open, incidence of mastitis, and lactation average SCS are reported here. Forty-eight first-calf heifers, blocked by expected calving date, were randomly assigned to control (CTL), parlor exposure (EXP), or pre-milk (PRE) treatments. EXP heifers were taken through the parlor without

milking and PRE heifers were milked for three weeks prior to expected calving. Five heifers were removed from the trial for reasons unrelated to treatments and six heifers left the herd in early lactation and were not considered reflective of lactation measures. MEM, MEF, MEP and lactation average SCS were obtained from DHIA records. Days to first service, number of services, and days open were obtained from herd records. Mastitis incidence was obtained from herd health recordings. The model used to analyze the data included fixed effects of block and treatment. MEM at the time of first service was included as a covariable in the analysis of number of services. MEM, MEF, and MEP were not significant ($P > 0.05$). Treatment did not effect days to first service but PRE heifers had significantly fewer ($P < 0.05$) total services and days open. Earlier return to normal levels of haptoglobin for PRE reported in previous work may be related to quicker return to reproductive health. Treatment effects were not significant ($P > 0.05$) for lactation average SCS or mastitis incidence. Results indicate no detrimental effects of prepartum milking on production and udder health and may indicate beneficial effects on reproductive performance.

Key Words: Prepartum milking, Heifers, Production

968 The influence of reproductive efficiency on income over feed costs in Holstein dairy herds in Ragusa Sicily. J. D. Ferguson*¹, D. T. Galligan¹, S. Ventura², S. Barresi², G. Alderisi², and G. Licitra², ¹University of Pennsylvania, University Park, ²Consorzio-Ricerca Filera Lattiero, Sicily.

A deterministic, spreadsheet model examined the relationship between reproductive efficiency and marginal income over feed cost (IOFC) in Ragusa Holstein dairy farms. Milk production was described for first and second parity animals based on production curves estimated from 12,946 Holstein records collected by the Ragusa DHIA. Milk production was adjusted for season of calving and two production levels for each parity group (LOW, 5,500, and 6,500 kg, HIGH, 7,500kg and >8,000 kg for parity 1 and 2+, respectively). The reproductive parameters were voluntary wait period (VWP) and pregnancy rate (PR), the multiplicative probability of pregnancy determined by the heat detection and conception rate. PR was varied in 11 steps (.10, .15, .20, .25, .30, .35, .40, .45, .50, .75, and 1.00) and VWP was 50 or 75 d postcalving. Dry matter intake was a function of days in milk, milk production, and average body weight at calving. The model used a sequence of 5 lactations beginning with first parity; reproductive efficiency determined length of production and season of future calving. Each lactation was terminated when a cumulative probability of pregnancy was > 99%. Dry period varied from 40 to 100 d as a function of lactation length. Cumulative IOFC was calculated as the income from milk (700 Italian Lire, (lr) x milk, kg) plus calves (200,000 lr/calf) minus the cost of feed for milk and dry cows. The cost of an average day open in Ragusa dairies was -5452.09 lr/cow/DOPN (3.21, US) for low feed costs and -5187.26 lr/cow/DOPN (3.05, US) for high feed costs. Higher production increased the loss per open day. Season of calving did not influence the cost of an open day, however milk production, VWP, PR, and feed cost influenced IOFC. It was always more profitable to have a higher PR regardless of season of calving.

Key Words: Days open, Economic efficiency, Pregnancy rate

969 Management of length of lactation and dry period to increase net farm income in a simulated dairy herd. M.E. French*, M.L. McGilliard, and R.E. Pearson, *Virginia Polytechnic and State University, Blacksburg.*

A computerized dairy herd simulation was developed to evaluate the economic impact of changing length of lactation relative to length of dry period in a dairy herd. Weekly production was generated for individual cows in a typical herd. Cows were dried off early when their milk yield for two consecutive weeks was less than a designated daily milk yield. They were replaced with fresh cows to maintain a constant number of cows in milk (98 to 102). A two by four factorial of dry-off strategies was designed for rates of lactation decline of 6% and 8%/mo and milk at dry-off of 8, 13, 18, and 23 kg/d. There were 100 cows in each herd and each of the eight scenarios was run for 10 herds, 80 herds total. Sizes of dry cow groups for 8, 13, 18, and 23 kg/d dry-off were 14, 17, 23, and 32% of milking and dry herd size, respectively. Daily milk increased with earlier dry-off: 30.4, 31.2, 32.3, and 33.7 kg/d per milking cow, whereas rolling yearly herd average decreased. Three scenarios of milk income minus feed cost, (+20%, average, -20%) were combined

with three dry cow costs, (+20%, average, and -20%). Nine combinations were analyzed statistically at each rate of lactation decline. Net cash income changed \$+3561, \$+1571, and \$-3051/yr per herd from 8 to 13 to 18 to 23 kg/d dry-off for 8% decline under the average economic situation. Net farm income changed \$+3170, \$+2945, and \$-1154. Under the best economic situation of high milk-feed income and low dry cow cost, net cash income increased with each successive increase in the dry-off criterion, \$+5086, \$+4248, and \$+921. Net farm income also increased by \$+4695, \$+5621, and \$+2819. Only in the most optimistic economic situations was it practical for a dairy business to adopt early dry-off above 13 kg/d per cow because other gains were small and variable. Dry-off at 18 and 23 kg/d was neither greatly profitable nor extremely unprofitable.

Key Words: Computer simulation, Lactation length, Net cash income

970 The interaction of a web-based dairy expert system and production benchmarks. A.M. Chapa*, J.W. Smith, L.O. Ely, M. Nakazawa, C. Ramakrishnan, and W.D. Potter, *University of Georgia, Athens*.

Dairy production benchmarks can be used to focus the initial point of inquiry for an expert system through the accumulation and analyses of data. Production benchmarks, calculated for Holstein herds in the southeast region, are used for screening measures of management efficiency. Herd records from the November and December 1998 test dates, accessed from the Dairy Records Management Systems, Raleigh, NC, were sorted and classified by herd size (up to 100, 100-149, 150-249, 250-499, and 500+ cows) and production level (14,000 - 22,000+ lbs in 1,000 lb increments), and categorized into management sections: production, feeding, somatic cell count, genetics, and reproduction. The univariate procedure of SAS was used to calculate percentile rankings (10, 25, 50, 75, and 90) based on herd size independent of production level. Additionally, means were calculated by production level independent of herd size for certain production variables. Values calculated from the percentile rankings and means by production level are placed into a database for use with an inference program for accessing the information to be used for analysis. A series of questions prompts the entry of herd data, available from the DHI 202 herd summary report, with the results displayed as a table showing the user values in relation to other herds and production levels. The evaluation may be continued into a specific area of management with additional questions regarding lactation groups and stages of lactation. Upon completion of data entry, simple mathematical calculations are used to identify possible problem areas. The results from the calculations are presented in a table and used to direct the types of questions asked by the expert system. By categorizing the user values and using simple calculations, the expert system will more efficiently identify areas of management for improvement and offer more reliable recommendations due to the initial evaluation of the producer information.

Key Words: Production benchmarks, Dairy management, Herd performance

971 Comparison of health parameters and milk production of cattle receiving an additional dose of E. coli naked core antigen vaccine for the prevention of coliform mastitis during the third month of lactation. G. Goodell*, *DUO Dairy Research Facility, Loveland, CO*.

Naked core antigen vaccine is used in dairy cattle to reduce the number and severity of cows with coliform mastitis. This study was conducted to evaluate an additional dose of core antigen vaccine and the effect it may have on the health and production of a cow during the mid-lactation period. This clinical trial was conducted on a 2500 cow dairy farm in Northern Colorado. Cows were milked 3 times a day. Cows were housed in uncovered pens with freestalls. No first-lactation cows were used. Both treatment and control cows enrolled received 3 doses of vaccine. The first dose was given at dry off. The second dose was given approximately 3 weeks prepartum and the third was given 2 weeks post partum. A fourth dose was given to treated cows between 70 and 110 DIM. Cows were assigned randomly to treatment or control groups at the time of enrollment, which occurred at the time of the fourth dose. All cows within a group were enrolled simultaneously. Five hundred animals were used for his particular study. Cows were kept as a group in the same pen so that all management and exposure factors were the same. Cows were monitored for 90 days after enrollment. For this study the

treated cows decreased an average of 2 pounds of milk the day after the dose was administered relative to control cows but recovered completely within 48 hours. Daily milk production was measured over the following 90 days of the trial and found to be 1.6 pounds higher for treated cows during this time. The incidence of mastitis was the same for both groups during this period however treated cows recovered, on average, 2 days sooner from a case of clinical mastitis. The conclusion was that the fourth dose reflected in the treated group acted to decrease milk loss due to mastitis and reduced the severity of clinical mastitis. It was also shown to cause a drop in milk production the day after administration however the effects were greatly nullified by the overall daily increase of milk production in the treated cows throughout the rest of the study.

Key Words: Mastitis, core antigen vaccine, milk production

972 An investigation of the factors affecting the adherence of a dry cow teat sealant in commercial dairy herds in Ontario. G. H. Lim*, K. E. Leslie, D. F. Kelton, C. Church, and J. TenHag, *University of Guelph, Ontario, Canada*.

A dry cow teat sealant can be used for protection of the teat-end. The efficacy of the sealant is likely associated with the time in which the sealant remains on the teat. Quarter-level and cow-level factors affecting adherence of the sealant have been previously identified. The objective of the current study was to identify herd management factors that have an impact on the number of days the teat-end was covered, as well as further investigate the importance of teat and cow characteristics. A total of 45 dairy herds, representing a broad range of management characteristics typical of the Ontario dairy industry, participated in the study. On each farm, for a period of 4-6 months, all cows in the herd were enrolled in the study at the time of drying-off. Specific teat and cow characteristics were recorded, and all teats were dipped in the sealant (DryFlex[®], Alfa Laval). Adherence was recorded at the teat level for 12 days. In addition, a herd survey was conducted to collect information on herd management practices specific to the time surrounding the dry period. Adherence data was collected from 733 cows. For the 2927 quarters, the average number of days teat-ends were covered was 5.3 ± 0.05 days. Adherence averages for the 45 farms ranged from 2.5 to 8.0 days. The standard deviation on each farm ranged from 0.5 to 3.8 days. The variation in adherence between cows within farms was more than twice that of the variation between farms. Ongoing statistical analysis will provide further information on the factors that significantly affect the outcome of days of teat sealant adherence. Measuring adherence is of practical use on a farm, since it is likely correlated to the efficacy of the sealant. The identification of herds with poor adherence results is also of importance. Management practices specific to such herds should be identified, so that they may be altered to effect an improvement in adherence. Alternate methods for improving adherence, such as dipping the teat twice in sealant, may also have a beneficial impact.

Key Words: Dry cow, Mastitis, Prevention

973 Association between heat stress prepartum, body condition score and production parameters of Holstein cows. L. Avendano-Reyes¹, J. W. Fuquay^{*2}, R. B. Moore², Z. Liu², B. L. Clark², and C. Vierhout³, ¹*Instituto de Ciencias Agricolas, Universidad Autonoma de Baja California*, ²*Mississippi State University*, ³*Dairy Records Management Systems*.

To estimate the association between heat stress during the last 60 d prepartum, body condition score and certain productive traits in the subsequent lactation of Holstein cows, 564 multiparous and 290 primiparous cows from four dairy herds in Mississippi were used. Maximum prepartum degree-days and maximum temperature-humidity index were computed measures used to quantify the degree of heat stress. Cows were scored for body condition three times: at dry off, at calving, and at 60 d postpartum. Production variables were obtained from DHIA forms at the end of the lactation. Multiple regression analyses were used to determine the relationship between prepartum heat stress and body condition change on postpartum production parameters. In multiparous cows, maximum temperature-humidity index affected milk production at 200 d negatively. One point of decrease in body condition score from calving to 60 d postpartum was associated with 246 kg more milk. One point of increase in body condition score from calving to 60 d postpartum was associated with 1.85 kg of less milk at peak of milk production. There was no effect of heat stress measurements on postpartum production performance of primiparous cows. Due to

differences in management practices, herd effect was present in some productive variables for both primiparous and multiparous cows. Heat stress prepartum affected negatively milk production postpartum when it considered ambient temperature and relative humidity.

Key Words: heat stress, prepartum, production parameters

974 Association between heat stress prepartum, body condition score and reproduction parameters of Holstein cows. L. Avendano-Reyes¹, J. W. Fuquay^{*2}, R. B. Moore², Z. Liu², B. L. Clark², and C. Vierhout³, ¹*Instituto de Ciencias Agricolas, Universidad Autonoma de Baja California*, ²*Mississippi State University*, ³*Dairy Records Management Systems*.

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Key Words: heat stress, prepartum, reproduction

975 Influence of environmental conditions on body temperature, dry matter intake, and milk yield for lactating cows from spring through summer in the southeast. J. W. West^{*}, B. G. Mullinix, and J. K. Bernard, *The University of Georgia, Tifton*.

Thirty lactating cows (22 Holstein, 8 Jersey) with shade but no cooling were used to determine the effects of environmental conditions on body temperature, intake, and milk yield. The study was conducted from April 28 through July 21 when weather conditions typically change from warm to very hot and humid in south Georgia. Daily maximum and minimum temperature and relative humidity were measured and temperature-humidity index (THI) was calculated. Ambient temperature (°C) mean (and range) minimum was 20.5 (range 9 to 26), maximum was 32.3 (range 23 to 38); relative humidity (%) minimum was 44.6 (range 25 to 78), maximum was 94.5 (range 77 to 100); THI minimum was 68.6 (range 50 to 77), maximum was 80.7 (range 69 to 89). There was a linear decline (P<0.0001) for milk yield across time which was much greater than normal decline with advancing lactation. There was a linear increase (P<0.0001) for p.m. body temperature which influenced DMI and milk yield. As THI increased, body temperature increased in a curvilinear fashion (P<0.0001), and a curvilinear decline for DMI and milk yield occurred (P<0.0001). Regressed on mean daily THI, at a THI of 72 and 76 cow p.m. body temperature (°C) increased 0.143 and 0.187 (Holstein) and 0.122 and 0.168 (Jersey) per unit increase in mean THI; DMI (kg) decreased 0.319 and 0.502 (Holstein) and 0.278 and 0.426 (Jersey), and milk yield (kg) decreased 0.575 and 0.864 (Holstein) and 0.336 and 0.503 (Jersey) per unit increase in THI. Instantaneous slopes revealed that at THI of 72 milk yield declined at a rate of 0.221, 0.911, and 0.575 kg/unit increase in THI for Holsteins when regressed on maximum, minimum, or mean THI, respectively. Jerseys were more heat tolerant than Holsteins, warming environmental conditions had a

curvilinear effect on body temperature, milk yield and DMI, and the environmental measure used influenced the magnitude of change observed for that variable.

Key Words: Heat stress, Intake, THI

976 A field study of dairy cow performance using different fan-cooling strategies. J.D. Sampson^{*}, C. Bowe, J. Denbigh, M. Ellersieck, J.N. Spain, D. Spiers, and J. Zulovich, *University of Missouri, Columbia*.

Previous environmental chamber studies have shown that fan-cooling at night increases heat dissipation above the level of fan cooling during the day. A field study was performed to determine benefit of night-cooling under "real-world" conditions. Study duration was 6 weeks during the summer using 30 Holstein cows. Cows were blocked by lactation number and days in milk into two different pens. Pens had either 24 hr(T24) or 12 hr night-time fan cooling (T12), with lot conditions alternated every two weeks, equaling a study period. Milk weights were taken daily. Respiration rate, rectal and skin temperatures were taken 3 days per week (Monday, Wednesday and Friday) and three times per day (0800, 1400, and 2000hrs). Relative humidity (RH), temperature humidity index (THI), dew point and barn air temperatures were recorded every 15 minutes using a data logger (Onset). Treatments for Period 1 were not significantly different in milk yield. Mean THI and Ta with 95% confidence intervals (CI) for this period were 75.17(CI=77.02-77.39) and 26.65(CI=26.48-26.82C), respectively. Milk yields for T12 were significantly lower than T24 (P=0.0002) in Period 2, where THI and Ta were 77.21(CI=77.02-77.39) and 28.42C(CI=28.26-28.58C), respectively. In Period 3 T12 and T24 were not significantly different in milk yields, and ambient conditions were 73.44(CI=73.27-73.61) and 25.30C(CI=25.14-25.46C) for THI and Ta, respectively. Relationships between ambient conditions and milk yield showed best fit by third order polynomial regression. Noted breaking points for milk yield were as follows: Mean THI=77; Max THI=81.5; Mean Ta=28C; Max Ta=33C. These limits were only surpassed in Period 2, which explained the separation of T12 and T24 responses under these conditions. Above these critical breaking points, the decline in milk yield was greater for T12 compared to T24 groups. Twelve hour night cooling was as effective as twenty-four hour cooling for milk yield performance as long as critical ambient conditions were not reached or sustained.

Key Words: Heat Stress, Dairy Cow, Cooling

977 Effect on milk production of adding fans and sprinklers during hot weather on an Arkansas dairy farm. J. A Pennington^{*1}, J. M Langston¹, D. E. Kratz¹, and M. C. Andrews², ¹*University of Arkansas Cooperative Extension Service, Little Rock, Arkansas*, ²*University of Arkansas Cooperative Extension Service, Clinton, AR*.

A demonstration was conducted to show the effects of adding sprinklers to the holding pen and fans to the feeding area on a dairy farm with 80 milk cows near Damascus, Arkansas, during hot, humid weather. A sprinkler system was installed on August 18, 1999, (day 0) between the am and pm milkings. A timer was installed three days later so that 0.1 cm of water was applied to cows in two minutes; fans then blew air over the cows for eight minutes to promote evaporative cooling and to complete the 10 minute cycle of the timer. Fans were previously in the holding pen, but fans without sprinklers were added to the feeding area where they operated continuously when cows were eating. The results shown below from the demonstration dairy (Demo D) and five nearby dairy farms (5 Dairy) which averaged 66.8 milk cows/herd indicate that milk production increased from cows after the sprinklers and fans were added to the management of the herd.

	Days -20 to -1	Days -10 to -1	Days 5 to 14	Days 5 to 24
	Milk Production/ Cow/Day			
Demo D	19.3 kg	19.1 kg	22.0 kg	21.9 kg
5 Dairy	18.1 kg	18.0 kg	19.6 kg	19.3 kg
	Changes in Milk/ Cow/Day vs. to -1			
Demo D	+1.0%	0.0%	+15.5%	+15.1%
5 Dairy	+0.5%	0.0%	+8.4%	+6.5%

Key Words: Dairy, Cow comfort, Heat stress

978 Effects of rbST on performance of Jersey cows in a thermal-stress environment. Z. Keister^{*1}, K Moss², R. Edling³, R. Collier¹, and R. Ax¹, ¹University of Arizona, Tucson, ²Mountain Shadow Dairy, ³Monsanto, Animal Agriculture.

The objective of this trial was to measure effects of cooling and rbST on milk yield, reproductive performance and health of Jersey cattle during summer thermal stress. Cows were divided into two groups based upon days in milk, parity and genetic index. The control cows (n=143) were housed in a pen with no cooling other than shade. The second group (n=142) was housed in a pen with a spray and fan system, utilizing 10 fans, each set to deliver approximately 180 m³/m air and 0.84 l/m water for evaporative cooling. One half of the animals in each group were randomly assigned to be treated with rbST, with all animals at least 63 d in milk at the start of the trial. Cooled vs no cooled d in milk were similar (114.3 d vs 113.2 d) at the start of the trial. Both groups had the benefit of a holding pen cooling system for approximately 30 min each milking, 2X/d. Daily milk weights were taken using the S.A.E. Afikin milk recording system. The trial began on July 1, 1999 and concluded on September 30, 1999. The statistical design was a 2X2 factorial with cooling and rbST as main effects. Cooling in combination with rbST increased milk yield compared to no cooling and no rbST, (25.9 versus 23.2 Kg/d, P<.05). Cooling and rbST effects on milk yield were additive, furthermore, cooling was associated with reduced health problems in the cooled rbST animals when compared to animals with shade only, without rbST, respectively. Incidences of mastitis (5 vs 16, P<.01) and laminitis (2 vs 7, P<.05), were both reduced. Reproductive performance was improved in cows given access to cooling (126 pregnant and 6 abortions) versus shade only (112 pregnant versus 13 abortions) P<.05. Additional income over cooling cost was \$.55/cow/day. Results indicated that cooling and rbST should maximize profit opportunity through increased milk yield, improved reproductive efficiency and reduced health costs.

Key Words: Thermal/Heat Stress, Cooling, Milk Yield

979 Productive and physiological response of Holstein steers under heat stress to an open space cooling system. A. Correa^{*1}, V. M. Ya'ez¹, A. P. Márquez¹, F. J. Verdugo¹, H. G. González¹, M. A. Tarazona², D. V. Armstrong³, J. C. Reynoso⁴, R. Fregoso⁴, and Z. Astarabadi⁵, ¹Universidad Autonoma de Baja California, ²Universidad de Sonora, ³University of Arizona, Tucson, ⁴Corrales San Carlos, Mexicali, Mexico, ⁵Open Space Cooling L. L. C..

Thirty-two Holstein steers (initial weight 273 kg) were used to evaluate the effects of an open space cooling system on weight gain, feed intake and respiration rate during a hot summer in the Mexicali valley, Mexico. The duration of the trial lasted 90 d with a daily maximum temperature-humidity index (THI) range of 84-90. The steers were allotted in two treatments according to their body weight. A control group (C) with shade only in the center of the pen (n=16) and a second group (n=16) with shade plus an open space cooling system (OSC). The open space cooling system consisted of a fan with 2.4m diameter blade that circulates 1416m³ of air/min and oscillation coverage of 90°. The amount of water discharged was 12 l min⁻¹. Weight gains were recorded biweekly and feed intake and respiration rate (14:00 h) twice weekly. Data were analyzed as a completely randomized design using the general linear model procedures of SAS. There was not significant difference in daily weight gain and feed intake, however the tendency to increase the productive performance and the reduction in the respiration rate in the steers under the cooling system indicate an improvement in their comfort and suggest that further study about these environmental modifications.

Treatment	Weight Gain (kg d ⁻¹)	Feed Intake (kg d ⁻¹)	Respiration Rate (breaths min ⁻¹)
Control	1.34 ^a	11.1 ^a	104 ^a
OSC	1.41 ^a	11.8 ^a	89 ^b

^{a,b} (P<.05)

Key Words: Heat stress, Steers, Cooling system

980 A comparison of freestall barns used by modernized Wisconsin dairy farms. J. Bewley^{*}, R.W. Palmer, D.B. Jackson-Smith, and D.E. Hemken, University of Wisconsin, Madison.

A primary objective of the Wisconsin dairy modernization survey was to compare options available to dairy producers related to types of freestall barns. Three hundred two herds that had increased herd size by a minimum of 40% between 1994 and 1998 were selected for this study. Comparisons were made for new versus remodeled facilities, barn design, bedding used, feeding strategy, manure removal systems, and animal handling facilities. Among respondents using freestall barns as their primary housing for the milking herd, 67% had new freestall facilities, 10% had remodeled facilities, and 23% had both new and remodeled facilities. Satisfaction with cow comfort, cow cleanliness, ability to move animals, manure management, and feeding convenience was higher for respondents using new facilities compared to those using remodeled facilities (P<0.05). Approximately 40% had 4-row barns, 25% had 3-row barns, 23% had 6-row barns, and 7% had 2-row barns. Labor efficiency was higher for 4-row and 6-row barns than for 2-row and 3-row barns. The most predominant freestall bases were sand (60%) and mattresses (29%). Average linear somatic cell score did not differ between respondents using mattresses and sand (P<0.05). Respondents using sand reported greater satisfaction with cow cleanliness and hock damage, and respondents using mattresses were more satisfied with manure management and bedding usage and cost (P<0.05). Feeding strategies included drive-through feeding (64%), drive-by feeding (18%), and outside feeding (8%). Respondents using drive-through feeding were more satisfied with feeding convenience than those using drive-by or outside feeding. The majority (78%) of respondents used tractors to remove manure while the remaining respondents used alley scrapers (11%), slatted floors (7%), or flush systems (2%). Respondents using alley scrapers and slatted floors were more satisfied with manure management and bedding usage and cost than those using only a tractor to remove manure (P<0.05).

Key Words: freestall, survey, expansion

981 A controlled study on the effect of free-stall alley surface and stall bedding on hoof and hock lesions in lactating Holstein dairy cattle. F.J. Vokey^{*}, C.L. Guard, H.N. Erb, and D.M. Galton, Cornell University, Ithaca, NY.

A 15-wk 3 x 2 factorial trial in a 400-cow university herd compared effect of 3 free-stall beds and 2 alley surfaces on hind hoof and hock lesions. Stalls were deep sand (S), multi-cell rubber-filled mattresses (M), or concrete (C). Mattress and concrete stalls were bedded with sawdust. Alley surfaces were parallel-grooved concrete (Ct) or 1.9-cm thick interlocking rubber mats (Rb). Prior to assignment, 120 primi- (n=69) and multiparous (n=51) cows were restrained on a tilt-table, professionally foot trimmed, and then scored by a veterinarian (CLG) for lesions in the sole and white line. Exclusions were for less than 30 DIM, more than 115 d pregnant, severe hoof or leg deformities, or severe laminitis. Cows were sorted by lesion score and then randomized in consecutive blocks of 3 to stall treatments. Due to animal availability, the Rb treatment began 31 d before the Ct but management was the same and stalls were reconstructed to identical dimensions. Hocks were scored non-blindly at wk 1 and 15; the change in score was calculated. After wk 15, a thin layer of horn was pared from the sole. The same veterinarian (blind to stall treatment) scored claws for lesions; the change was calculated. Days spent out of the assigned pen for health reasons were recorded. Analysis was performed using rank-sum, Kruskal-Wallis, and χ^2 tests. Hoof score increased in all groups but less on Rb (P=0.02). Hoof score did not differ by stall treatment. CtC cows had a greater increase in hock score than cows in CtS and RbS (P=0.0003). Hock scores increased less for cows in S than in M and C (P=0.0001). More cows from Ct and C spent more than 10 days out of the assigned pen than from Rb (P=0.05) and other stall groups (P=0.02), respectively. Rubber floors in free-stall barns were protective for hoof lesions compared to concrete. Consistent with other studies, deep sand stalls were most protective for hock lesions.

Key Words: Hoof Lesion, Hock Lesion, Free-Stall Design

982 Measuring water use in California dairy facilities. C. Batchelder¹, I. Zallo², B. Reed*¹, and D. Meyer², ¹University of California Cooperative Extension, ²Department of Animal Science, University of California, Davis.

Meters were installed on fourteen (14) dairy facilities in the Central Valley of California to measure water use during milking and to calculate the contribution to 120 d liquid storage capacity requirements. Cow drinking water was excluded from calculations. Dairies were categorized as small (<450 milk cows) or large (>650 milk cows). Small herd sizes ranged from 125 to 445 milk cows. Large herd sizes ranged from 691 to 1287 milk cows. Average herd sizes by category were: 309 and 945. Use per cow was calculated by dividing total metered water use by cows milked. Range, average and standard deviation for water use (l/cow/d) in small herds were: 167 to 420, 269, 98. Ranges, average and standard deviations for water use (l/cow/d) in large herds were: 204 to 261, 231, 49. Ranges for the 120 d liquid storage capacity (m³) contributions from water used during milking were: 2821 to 15,511 and 20,240 to 31,743 for small and large herds respectively. One dairy reconfigured sprinkler pens and reduced water use per cow by 129 l/d. Dairies can benefit from water monitoring and conservation efforts. Reducing water use can decrease storage requirements significantly.

Key Words: Water, Conservation, Storage

983 Factors affecting the estimation of time spent on essential work routine elements in dairy parlors. N.R. St-Pierre*, *The Ohio State University, Columbus.*

A significant proportion of total labor costs on US dairy farms occurs in the dairy center. An electronic data logger was designed to estimate the amount of labor time spent on each of the seven essential work routine elements (EWRE) and on various non-essential activities during milking. The logger was used to record the activities of milkers in 25 Ohio milking parlors varying in size from double 8 to double 16. On the day of the visit, the farm was also evaluated for a wide variety of criteria thought to influence cow throughput. Criteria included types of housing, types of bedding, stall designs and cleanliness, experience and training of milkers, elements of the work routine (e.g. spray or dip), equipment characteristics, cow characteristics, and grouping strategies. Additionally we evaluated the effect of the level of experience with the data logger and the length of the logging session on the accuracy of results as well as the effect of the session on the repeatability of the results. A bootstrap procedure was used to estimate the length of data recording necessary to estimate mean EWRE times with errors of at most 10%. Results showed that estimated mean EWRE times were within 10% of the true mean 95 % of the time after the recording of six consecutive cycles. The level of experience of the person doing the data recording had a significant effect on accuracy. Data recorded during the first two sessions following the initial training had significantly larger variances ($P < 0.05$) than data from the following sessions. Many factors outside the milking parlor impact significantly on cow throughput and labor efficiency in the parlor.

Key Words: Milking Parlor, Labor Efficiency, Essential Work Routine Elements

984 Manure sampling for improved nutrient management on animal farms. Z. Dou¹, R. Allshouse*¹, J. Toth¹, R. Boston¹, and J. Ferguson¹, ¹University of Pennsylvania, Kennett Square.

One of the Best Management Practices in animal manure management is to formulate manure application rates based on manure nutrient content and availability and crop nutrient requirements. However, when conducting manure sampling for nutrient analyses, one question often arises: how many samples are needed in order to get a good representative sample? We investigated this issue with a statistical approach by combining intensive sampling and sample analyses with a computer program. We took serial samples from three dairy farms (Farms A, B, C) and a broiler operation (Farm D); the dairy samples were collected periodically during the course of emptying the manure storage, the broiler samples were taken from multiple locations of litter piles prior to the manure hauling. Total number of samples (designated as the **grand sample set**) is: 34, 35, 20, 32 for farms A, B, C, D, respectively. All samples were analyzed for DM and concentrations of total P, TKN, and NH₄; the means of these parameters were obtained for each farm and

designated as the **grand means**. A computer resampling procedure was used to randomly withdraw, from the grand sample set, subsets of 3, 5, or 10 samples, each set for 10,000 times (designated as the **resampling set**). Means of the parameters were obtained for the resampling sets (designated as the **resampling means**), which were compared with the relevant grand means. Finally, the frequency at which the resampling means fell within ± 5 , 10, or 15% of the grand means was determined. For all four farms, the frequency of resampling means falling within ± 5 , 10, 15% of the grand means increases as the size of the resampling (3, 5, or 10) increases. At the $\pm 5\%$ level, the frequency varies a great deal among the four farms, ranging from 35% of the time to as high as 100% of the time. At the $\pm 10\%$ level, the frequency was $>74\%$ for all the parameters across the four farms. Implications of this study on manure sampling will be discussed.

Key Words: Sampling, Manure, Nutrients

985 Implementation of innovative best management practices and a nutrient monitoring system to reduce nitrogen and phosphorus loading from dairy cattle production systems. G. M. Goodall*¹, M. A. Tomaszewski¹, E. R. Jordan², S. R. Stokes³, and L. W. Greene⁴, ¹Texas A & M University, College Station, ²Texas A & M Research and Extension Center, Dallas, ³Texas A & M Research and Extension Center, Stephenville, ⁴Texas A & M Research and Extension Center, Amarillo.

The objective of this study was to monitor the environmental effects from dietary nitrogen and phosphorus loading via ration management. The potential impact of elevating nitrogen and phosphorus in the environment from application of wastewater and manure is a significant concern to the dairy industry. Overfeeding degradable protein can upset normal rumen function and result in excess nitrogen being excreted into the environment. Similarly, overfeeding phosphorus can result in soil accumulation. During the course of 18 months, eight (8) Texas co-operator herds were monitored through monthly feed, fecal and milk samples. Daily bulk tank samples were obtained to determine milkfat, protein, MUN (Milk Urea Nitrogen), somatic cell count, nitrogen, phosphorus and trace minerals. The cooperators were selected to represent pasture-grazing herds and Total Mixed Ration (TMR) fed herds. Overall ration phosphorus levels averaged 0.54% (SD = 0.122), while ration protein averaged 18.49% (SD = 2.24). Fecal nitrogen levels averaged 2.67% (SD = 0.258), while the fecal phosphorus averaged 1.03% (SD = 0.165). The MUN levels averaged 14.6 mg% (SD = 2.26). The rations were evaluated and reformulated using the Cornell Net Carbohydrate and Protein Model to compare the nitrogen and phosphorus levels. The feeding system significantly effected MUN, peak milk and fecal nitrogen. The grazing herds had significantly higher MUN levels and significantly lower peak milk production. Fecal phosphorus levels were significantly effected by ration phosphorus. This data indicates the need to monitor and adjust intake of protein and phosphorus.

Key Words: Dairy-cows, Environment-nitrogen and phosphorus, Monitoring-milk, fecal, MUN

986 Management effects on nutrient loading and losses from dairy farms. C. A. Rotz*¹, A. N. Sharpley¹, and L. D. Satter², ¹USDA/ARS, University Park, PA, ²USDA/ARS, Madison, WI.

Management decisions can impact the long-term sustainability of dairy farms. Computer models provide useful tools for evaluating these impacts before they are implemented. A representative farm with 400 Holstein cows (producing 11,000 kg/cow/yr) and their replacements on 300 ha of silt loam soil was simulated over 25 yr of Pennsylvania weather using a whole farm model (DAFOSYM). Multiple simulations predicted the effects of animal density, herd production, and feeding strategy on N loss, P balance, and farm profit. Reducing the land area to 200 ha nearly doubled N losses and increased soil P accumulation by 15 kg/ha/yr with little change in farm profit. At 400 ha, the farm was near a long-term P balance with an N fertilizer requirement of 50 kg/ha. A 10% increase in herd production through the use of BST provided a small increase in N loss and soil P level; whereas, a 25% drop in production reduced N losses 10% and P buildup by 3.6 kg/ha/yr. Changing the breed to Jerseys while increasing animal numbers to maintain the same sale of fat corrected milk increased N losses 45% with a small increase (1.8 kg/ha/yr) in excess P. Compared to soybean meal as the sole protein feed, including a low RDP feed in rations reduced N volatile loss 35%,

reduced N leaching loss 20%, and increased production and profit with little effect on soil P. Increasing the feeding of P to 20% above the NRC recommended level (common practice) increased the long-term buildup of soil P by 8 kg/ha/yr; whereas, a 20% reduction provided concurrent farm balances of both N and P. Shifting from low forage rations to maximum use of forage increased the purchase of alfalfa hay and reduced grain imports, which increased N losses slightly with little effect on P balance and farm profit. Changing from a corn and alfalfa rotation to all corn reduced N volatilization loss 14% and increased leaching loss 22% with little effect on soil P. For further analysis of dairy production systems, the DAFOSYM software is available at the Internet address <http://pswmrl.arsup.psu.edu>.

Key Words: Dairy farm, Nutrient management, Economics

987 Methods of processing affect absorption of IgG from colostrum supplement products in neonatal calves. J. D. Quigley*, M. L. Miller, and C. A. Jaynes, *American Protein Corp., Ames, IA*.

Provision of an adequate mass of IgG within the first 24 h of life is essential to health and survival of neonatal calves. Maternal colostrum (MC) may provide inadequate amounts of IgG for successful passive transfer; therefore, colostrum supplement products (CSP) have been developed. However, apparent efficiency of IgG absorption (AEA) from many CSP is poor. Methods of preparation may influence absorptive kinetics of IgG in CSP. Our objective was to determine if methods of processing influence absorption of IgG from CSP. The CSP were prepared by collecting, processing and spray drying edible grade bovine serum (BS1) or further processing bovine serum by three methods (A, B, or C) to increase IgG concentration of the final CSP to approximately 27% IgG. Holstein bull calves (n = 80) were used in the study. Calves (birth BW = 43.8 kg) were removed from the dam within 5 min of birth and were fed CSP or MC within 2 h. All CSP were reconstituted in 1.89 L of water and 454 g was fed at approximately 1 h and at 8 h (BS1 only). Blood was collected by jugular venipuncture, plasma IgG was determined by turbidimetric immunoassay at 0.3 and 24 h of age and AEA was calculated. Plasma IgG at 24 h of age was lowest in calves fed BS1; plasma IgG in calves fed CSP did not differ from concentrations in calves fed MC. Mean plasma IgG at 24 h were 10.3, 4.1, 9.4, 9.1 and 9.8 in calves fed MC, BS1, CSP-A, CSP-B, and CSP-C, respectively. Intakes of IgG were 100, 95, 119, 119, and 119 g, respectively. Mean calculated AEA were 38, 16, 31, 29 and 32%, respectively and were lower in calves fed BS1. Method of preparing BS1 (removal of lipid from serum prior to spray drying) reduced plasma IgG concentration and AEA. Further processing serum to produce CSP did not impair absorption of IgG or AEA. Method of processing can significantly impact efficiency of IgG absorption from CSP. Provision of IgG to prevent failure of passive transfer is possible with CSP containing >20% IgG and fed at 454 g per dose.

Key Words: Calves, Colostrum, Immunoglobulin

988 Effect of pH on IgG absorption in neonatal calves. J. D. Quigley*¹, R. E. James², and P. French², ¹*American Protein Corp., Ames, IA*, ²*Virginia Tech, Blacksburg*.

Formulation of colostrum supplement products (CSP) may influence the absorption of IgG and apparent efficiency of IgG absorption (AEA). The pH of maternal colostrum (MC) is approximately 6.0; the pH of most CSP are significantly greater than 6.0. The AEA from some CSP is poor; it is not clear if differences in pH between MC and CSP might be responsible for observed differences in absorption kinetics of CSP. Our objective was to determine if differences in pH influence plasma IgG and AEA in CSP fed to neonatal calves. Newborn calves (n = 60) were fed MC (n = 12) or a CSP derived from edible bovine serum (n = 48; Lifeline Calf Nutritional Colostrum Supplement, American Protein Corp., Ames IA). Holstein (n = 45) and Jersey (n = 15) calves were used. Sodium citrate was added to CSP to achieve pH in product of 7.5, 7.0, 6.0 and 5.0. Calves were collected prior to nursing, weighed, moved to individual pens and fed pooled colostrum (2 L/feeding) or CSP (454 g reconstituted in 2 L of water) at 1.2 and 12.6 h of age which provided a total of 156 (MC) or 90 (CSP) g of IgG. Jugular blood was sampled at 0 and 24 h of age for determination of plasma IgG by turbidimetric immunoassay. Mean plasma IgG concentrations at 0 and 24 h of age were 0 and 6.7 g/L and were markedly higher in calves fed MC compared to CSP (10.7 vs. 6.5 g/L) and were higher in Jersey vs. Holstein calves (8.5 vs. 6.1 g/L). Mean plasma IgG at 24 h were 10.7, 6.6, 6.5, 5.8, and

7.2 g/L for calves fed MC and CSP at pH = 7.5, 7.0, 6.0 and 5.0, respectively. Mean AEA were 21, 19, 20, 17 and 24%, respectively. All calves were fed by esophageal feeder, which may have reduced AEA. Mean calf mortality and number of days treated for enteric or respiratory disease to 60 d of age were unaffected by treatment and were 16.7% and 1.4 d, respectively. These data indicate that pH of colostrum supplements between 7.5 and 5.0 do not markedly influence plasma IgG concentration or AEA.

Key Words: Calves, Colostrum, Immunoglobulin

989 Effects of accelerated milk replacer feeding at 2 protein levels on performance and economics in Holstein heifer calves. D. R. Catherman*, *Strauss Feeds, LLC, Watertown, WI*.

Ninety six Holstein heifer calves (average 40.2 kg BW) were utilized in a study to evaluate the effects of milk replacer (MR) protein level and feeding rate on performance and economics. Calves were allotted by weight to one of four treatment groups. Calves were fed MR (20% fat) as follows: treatment 1, 20% protein at 454 g/d; treatment 2, 20% protein at 568 g/d; treatment 3, 22% protein at 454 g/d; and 22% protein at 568 g/d for 28 d. MR feeding rate was reduced to either 228 or 284 g/d for d 29 to 35. Calves were weaned on d 35 and feed intake was recorded for 42 d. Water and starter grain (18% protein) were offered free choice from d 3. Total MR intakes were 13.5, 16.9, 13.5, and 16.9 kg for treatments 1 through 4, respectively. No differences were observed in weight gains between 0 and 21 d and between 21 and 42 d, although the calves fed 22% protein tended to gain more weight. Overall weight gain (0 to 42 d) was higher (P<.05) for treatments 3 (25.3 kg) and 4 (26.0 kg) than treatment 2 (20.3 kg). Treatment 1 was intermediate (24.5 kg). Total starter intake was lower (P<.05) for treatment 2 (23.5 kg) than for treatments 1 (33.9 kg), 3 (32.8 kg), and 4 (31.5 kg). Feed to gain ratio was lower (P<.05) for treatment 3 (1.83) than for treatment 2 (1.99). Treatments 1 (1.93) and 4 (1.86) were intermediate. Feed cost per kg of gain was lower (P<.05) for treatments 1 (\$1.23) and 3 (\$1.17) than treatment 2 (\$1.63). Treatment 4 (\$1.63) did not differ from the other treatments. Scour scores and cost and number of medical treatments were not different between groups. Based on these data, increasing protein content of MR from 20 to 22% improves gain slightly. Increasing feeding rate increases cost per kg of gain and resulted in only a slight increase in gain at 22% protein, and a decrease in performance at 20% protein. More work is needed to define the effects of higher MR feeding rates on performance and economics in Holstein heifer calves.

Key Words: calves, milk replacer, feeding rate

990 The impacts of management factors on the costs of replacement dairy heifer programs. P. R. Tozer, *The Pennsylvania State University, University Park*.

A dynamic programming model of a dairy replacement herd was developed to analyze the impact different management variables had on the cost of rearing replacements for a representative dairy herd of 100 cows. A base herd dynamics model was developed using Pennsylvania and national average information as the basis for the parameters included. Using the base model for comparison, the impact of management factors including: age at first calving; calving interval; number of replacement heifers born; pre-weaned heifer death rate; pregnancy rate of replacement heifers; and the number of replacements required; was examined. From the base model and using a value of \$1200 per heifer, the total cost of rearing sufficient replacements for a 100 cow herd was \$30934 with a pre-weaned heifer culling rate of 5%. Of the management factors examined the age at first calving and the number of replacements required had the largest impact on the costs of rearing replacements for the milking herd. A higher than average age at first calving increased the cost of rearing by 9% and a lower than average age at first calving reduced the costs by 18%. A relatively high replacement rate caused the costs of rearing replacements to rise by 20%, whereas a relatively low rate reduced the costs by 23%. Parametric programming determined the value at which the farmer would retain all heifers until after they calved is approximately \$1600.

Key Words: mathematical programming, replacement management, economics

991 Predicting body weight in Holstein heifers using pelvic width measured between greater trochanters of the femurs. A. L. Skidmore^{*1}, C. J. Sniffen², and K. Ballard², ¹Attica Veterinary Associates, PC, Attica, NY, ²W. H. Miner Agricultural Research Institute, Chazy, NY.

The purpose of this study was to evaluate if measuring pelvic width, the distance between the greater trochanter on the left and right femurs, was predictive of body weight in Holstein heifers. Pelvic widths and body weights were measured on 240 heifers. Pelvic widths were measured to the nearest 0.5 cm. Body weights were recorded with electronic scales at the same time pelvic widths were measured. Body weights ranged from 55 kg to 355 kg. Pelvic widths ranged from 21.0 cm to 43.5 cm. A linear model, least square means analysis indicated that hip width is a significant predictor of body weight ($P < 0.0001$). Ninety-three percent of the variation in body weight was explained by hip width ($R^2 = 0.927$). Hip width and body weight have a linear relationship within the weight range represented by this data set. Adding a quadratic term to the model only slightly increased the R^2 ($R^2 = 0.934$). This would indicate that the relationship between hip width and body weight might not be linear when data from a larger range of body weights are included in the model. In conclusion, pelvic width is predictive of body weight in 55 kg to 355 kg Holstein heifers when measured as the distance between the greater trochanter on the left and right femurs.

Key Words: Heifers, Hip width, Body weight

992 Effects of monensin and lasalocid on growth, feed intake, and feed efficiency in dairy calves. J.A. Isch^{*1}, J.E. Shirley¹, M.V. Scheffel¹, E.C. Titgemeyer¹, and E.E. Thomas², ¹Kansas State University, Manhattan, ²Elanco Animal Health, Greenfield, IN.

One hundred Holstein heifers were used to examine the effects of monensin (Rumensin[®]) and lasalocid (Bovatec[®]) included in calf starter and grower diets. Heifers were assigned alternately at birth to a starter feed containing either monensin (31 mg/kg, 90% dry matter basis) or lasalocid (44 mg/kg, 90% dry matter basis). The lasalocid group was switched to a starter feed containing 31 mg lasalocid/kg (90% dry matter basis) at 6 weeks of age. Both groups were switched at 8 weeks of age to grower diets designed to deliver 100 mg/heifer daily of either monensin or lasalocid. No treatment differences were observed between birth and 8 weeks of age. Heifers were moved from individual hutches at 8 weeks of age to group pens (five heifers/pen) and remained on the same treatment for the next 84 d. Pen feed intakes were measured and used to evaluate DMI differences. During this 84-d period, heifers receiving monensin gained more weight ($P = .02$) at a faster rate ($P < .01$) and tended to be more efficient ($P = .22$) than heifers fed lasalocid. No differences were observed in feed intake, skeletal growth as measured by hip height, or body condition score.

Key Words: Replacement Heifers, monensin, lasalocid

993 Assessment of the economics of Megalac[®] use by computer simulation. M. L. Kinsel^{*1}, W. K. Sanchez², and E. Block², ¹Agricultural Information Management, Nampa, ID, ²Church & Dwight Company, Inc., Princeton, NJ.

Feeding calcium salts of fatty acids (CSFA), such as Megalac[®], has been shown to protect rumen microbes from the adverse effects of fat and may lead to higher production levels, improved fertility, and reduced dry matter intakes. Despite the evidence of potential benefits in addition to increased milk production, no studies have attempted to quantify the overall economic return of CSFA use to the dairy enterprise. The objective of this study was to estimate by computer simulation the six year economic return of Megalac use given differing effects on milk production, reproductive performance, and dry matter intake. Ten simulation runs each were conducted for three levels of milk production effects, three levels of first service conception rate effects, three levels of second or higher service conception rate effects, and two levels of dry matter intake effects plus a baseline scenario for a total of 550 simulation runs. Megalac was simulated to be fed at 2.2% of the total ration dry matter at a cost of \$800 per dry matter ton for cows that were producing more than 36.3 kg of milk. For each simulated run an annualized six year annuity value was calculated. Statistical analysis consisted of multiple linear regression of the annuity value by changes in milk response, changes in reproductive effects, and changes in dry matter intake. All

effects (increasing milk production, improving first service conception rate, improving second or higher service conception rate, and reducing dry matter intake) led to statistically significant improvements in economic return ($R^2 = 0.96$). The largest unit return was related to improving milk production one kg/cow/d (\$56.36 annual return per cow), followed by reducing dry matter intake one kg/cow/d (\$29.37 annual return per cow), improving second or higher service conception rate one percent (\$4.08 annual return per cow), and improving first service conception rate one percent (\$2.28 annual return per cow), respectively. Based on effects reported in early lactation and reproductive studies, the annual profit per cow from Megalac use would be \$190.68.

Key Words: Economics, Calcium Salts of Fatty Acids

994 Evaluation of feed additives in the diet of lactating dairy cows. R.H. Phipps^{*1}, J.D. Sutton¹, D.E. Beever¹, M.K. Bhat², G.F. Hartnell³, J.L. Vicini³, and D.L. Hard³, ¹Centre for Dairy Research, The University of Reading, UK, ²Institute of Food Research, Norwich, UK, ³Monsanto Company, St Louis, MO.

Holstein-Friesian cows (86 multiparous and 37 primiparous) were used in an 16-week continuous design study to determine the effect of three additives on feed intake and milk production. At lactation week 5 animals were allocated to four treatments: T1 (control no additive), T2 (Additive D), T3 (Enzyme A) or T4 (Enzyme B). The TMR fed contained 57% forage (maize and grass silage 3:1 DM ratio) and 43% concentrate with a CP, NDF, NSC and TDN content of 20.3, 34.5, 36.3 and 66.8% DM. The xylanase and endoglucanase activity of Enzymes A and B were 38,883, 6,914 and 26,483, 2,645 mol/min/g. Additive D contained soluble sugars and dicarboxylic acids. Cows allocated to T2 received 0.227 g Additive D/20 kg DM of TMR, while those on T3 and T4 received the TMR treated with either Enzyme A, applied to forage at 1.25 l/t of forage DM, or Enzyme B at 2.0 l/t of total DM. There was no parity x treatment interaction and no significant treatment effect on DM intake with mean values for cows and heifers being 20.4 (s.e.m. 0.29) kg DM/d and 16.3 (s.e.m. 0.44) kg DM/d. Mean milk yields for cows for T1-T4 were 30.3, 30.8, 29.9 and 31.2 (s.e.m. 0.56) kg/d, with corresponding values for heifers of 26.0, 26.1, 25.9 and 26.4 (s.e.m. 0.83) kg/d. Whilst there was no significant effect the increase of 0.9 kg/d when comparing the control with Enzyme B for cows is noted. Treatment effects on milk composition were not significant. Milk fat and protein values for cows for T1-T4 were 4.05, 3.88, 4.04 and 3.91 (s.e.m. 0.116)% and 3.41, 3.39, 3.40 and 3.36 (s.e.m. 0.035)%. Corresponding values for heifers (3.85, 3.89, 3.63 and 3.45 (s.e.m. 0.173)% milk fat and 3.26, 3.29, 3.29 and 3.36 (s.e.m. 0.053)% milk protein) also showed no significant effects. However the decline in milk fat content of heifers receiving Enzyme B suggests changes in pattern of rumen fermentation. The results of the current study showed that the inclusion of the additives produced only small and non significant effects on feed intake, milk yield and composition.

Key Words: Cell-wall degrading enzymes, Feed intake, Milk production

995 Effect of cell-wall degrading enzymes and method of application on feed intake and milk production of Holstein-Friesian dairy cows. R.H. Phipps^{*1}, J.D. Sutton¹, D.E. Beever¹, M.K. Bhat², G.F. Hartnell³, J. Vicini³, and D.L. Hard³, ¹Centre for Dairy Research, The University of Reading, UK, ²Institute of Food Research, Norwich, UK, ³Monsanto Company, St Louis, MO.

Fifty-one multiparous and nine primiparous Holstein-Friesian dairy cows in mid lactation were used in a ten week continuous design trial to determine the effect of method of application of cell-wall degrading enzymes on feed intake and milk production. All cows received ad libitum the same TMR containing, on a DM basis, 57% forage (maize and grass silage in a 3:1 ratio) and 43% concentrate. The CP, NDF, ADF, NSC and TDN values of the TMR were 18.6, 50.6, 34.6, 18.9 and 68.8% DM. There were three treatments: T1 was a control ration with no enzyme, T2 had enzyme added to the TMR during mixing (2 l/t of TMR DM), and T3 had enzyme added to the concentrate prior to mixing (5.1 l/t concentrate DM). Treated concentrate was prepared weekly. The xylanase and endoglucanase activities of the applied enzyme were 26480 and 2640 umol/min/gram of the enzyme. As there were no treatment x parity interactions data are presented for all animals. Respective means and s.e.m for T1-T3 were 17.8, 18.2, and 18.6 (0.42) kg/d for total DM intake, 26.6, 27.4 and 26.9 (0.42) kg/d for milk yield, 3.97, 3.88 and 3.95

(0.123) for fat%, 3.42, 3.36 and 3.47 (0.036) for protein%. Enzyme application and its method of application had no significant effect on DM intake and milk production. These results are at variance with recent papers indicating the application of cell-wall degrading enzymes can result in increases in feed intake and/or milk production. The differences may be due to a number of factors including type and rate of enzyme application, optimal conditions for enzyme activity and diet composition. Further work is needed to determine the effect of enzymes on feed intake, milk production and feed quality.

Key Words: Cell-wall degrading enzymes, Feed intake, Milk production

996 Rumens-stable choline use in transition dairy cows improves early lactation milk yield. J. Siciliano-Jones¹ and D. Putnam*², ¹F.A.R.M.E Institute, Homer, NY, ²Balchem Corporation.

Six sites were used to determine the effects of rumen-stable choline (RSC) (ReashureTM choline, Balchem Corporation, Slate Hill, NY), fed to transition dairy cows, on early lactation milk yield. The trial began in January, 1999 and continued through August, 1999. The trial was conducted in the following design: control period, treatment period, control period. All prefresh (approximately 21 to 0 d precalving) and early postfresh (approximately 0 to 40 DIM) cows were either in the control or treatment period. Treatment consisted of supplementing 60 g of RSC per cow per day. Periods were approximately 40d in length. Cows were coded as RSC-supplemented only if their fresh date was at least 3 weeks after RSC feeding began. Cows were coded as controls if their fresh date was at least 20 days after the end of RSC feeding. The initial control period was defined as a period of time equal to the RSC-feeding period that occurred prior to initiation of RSC feeding. The mixed procedure in SAS[®] was used to determine treatment effects on monthly milk weights. Data were analyzed independently at each site. Independent variables were cow, treatment, observation, and test date. Observation was defined as test date minus January 1, 1999 and treated as a repeated factor. Fixed factors were treatment and test date; cow was random. Parity and DIM served as covariates. A total of 816 observations were collected for RSC fed cows and 1444 for unsupplemented controls. Treatment by test date interactions were not significant ($P > .05$) and were pooled into the error term for all locations. Supplementation with RSC significantly ($P < .05$) increased milk production at 3 of the 6 sites; milk yield averaged 40.9, 34.8, and 37.4 kg d⁻¹ with RSC versus 37.0, 31.5, and 36.0 kg d⁻¹, respectively, during the control periods. For the other sites, RSC did not significantly increase milk production; milk yield with RSC was numerically higher than for controls at 2 of the 3 sites. Supplementing transition dairy cows with RSC can significantly improve performance in early lactation.

Key Words: Choline, transition cow, milk yield

997 Production response of lactating ewes to increasing dosage of recombinant bovine somatotropin. D. K. Aaron*, D. G. Ely, W. P. Deweese, E. Fink, and B. T. Burden, University of Kentucky, Lexington.

Production response to increasing dosage of recombinant bovine somatotropin (bST, Somatotrope) was measured on 24, multiparous, spring-lambing Polypay ewes (70 kg), each nursing twin lambs during a 63-d experiment. The lactation diet contained 63% roughage and 37% concentrate. Ewes were fed at 0800 and 1600 so daily intake equaled 5.2% BW. Lambs, separated from ewes, were allowed ad libitum access to a creep diet during the same times. Ewes and lambs were individually weighed and ewes were condition-scored and machine-milked every 7 d beginning on d 12 of lactation. Ewes received s. c. injections of either an oil placebo (0 mg bST; n = 8), 160 mg bST (n = 8), or 240 mg bST (n = 8) on d 26, 40, and 54. As bST dosage increased, estimated 24-h milk production increased in linear fashion on d 33 (2431, 3170, and 2997 g; $P < 0.01$), d 40 (2204, 2603, and 2562 g; $P < 0.10$), d 47 (2352, 2826, and 2736 g; $P < 0.05$), and d 61 (2043, 2435, and 2365 g; $P < 0.04$). In contrast, milk production response was quadratic ($P < 0.10$) on d 54 and 68 with highest yields at 160 mg. Milk production efficiency and milk DM and fat contents followed similar patterns. Neither mastitis incidence nor milk somatic cell count was affected by bST treatment. Ewes in all three groups tended to gain weight and condition, but no significant differences were found. Beginning on d 40 and continuing through weaning on d 68, twin lamb weights increased linearly ($P < 0.06$) as ewe bST dosage increased. Also, creep feed intakes tended to be higher for

lamb pairs nursing bST-treated ewes. Over the entire collection period, ewes receiving 0, 160, and 240 mg bST produced 130.5, 152.9, and 147.8 kg total milk (linear, $P < 0.05$), had milk production efficiencies of .62, .69, and .70 (linear, $P < 0.03$), and had lamb production efficiencies of .16, .17, and .18 (linear, $P < 0.08$). Lamb pairs nursing ewes treated with 0, 160, and 240 mg bST had total gains of 37.3, 41.2, and 43.1 kg (linear, $P < 0.02$) and 60-d adjusted weaning weights of 50.0, 54.9, and 54.5 kg (linear, $P < 0.07$).

Key Words: Ewes, Somatotropin, Lactation

998 Phosphorus characteristics in swine manure fed with control vs. phytase treated diets. Z. Dou*, R. Allshouse, P. Pitcher, J. Toth, D. Galligan, J. Ferguson, and C. Ramberg, University of Pennsylvania, Kennett Square.

Manipulating animal diet formulation to improve nutrient utilization efficiency while reducing nutrient excretion in manure is a valuable tool in animal agriculture nutrient management. Phytase is an enzyme that can increase the bioavailability of P in corn and soybean meals for pigs and chickens and thus replace some of the inorganic P supplementation, hence reducing manure P excretion. We conducted a feeding trial to investigate the impact of phytase feeding on the forms and fraction distributions of P in pig manure. The experimental design was a 2 x 2 latin square, replicated eight times, with eight growing pigs blocked on weight and randomly assigned to a control diet or a phytase treated diet. Both diets were formulated according to NRC recommendations for growing pigs. The actual feeds, prepared by a local feed company and fed to the experimental pigs, contained 0.69% total P for the control and 0.66% total P for the phytase treated diet, respectively, with 0.33% available P for both diets. Manure was collected and samples taken for total P and fractionation analyses. Total P in manure was reduced from 15.64 mg/g in the control to 13.33 mg/g in the treated samples ($P=0.02$). The amounts of P (mg/g) released through a sequential extraction from manure of control vs. treatment are: 9.27 vs. 7.83 ($P=0.06$) in water, 3.37 vs. 2.98 ($P=0.02$) in NaHCO₃, 0.23 vs. 0.14 ($P=0.01$) in NaOH, and 2.77 vs. 2.38 ($P=0.27$) in HCl solutions, respectively. However, the relative fraction distributions, expressed as the percentage of total P extracted by each solution, did not differ for control vs. treated samples. Nevertheless, the P fraction extracted by a single extraction of water for 1-hr averaged 19.3% for the treated samples, comparing to 22.0% for the control ($P=0.15$), suggesting the tendency of reduced most vulnerable P fraction with the phytase treatment.

Key Words: Phytase, Manure, Phosphorus

999 Fender design and insulation effects of farrowing huts on productivity of outdoor sows and piglets. A. K. Johnson*¹, J. L. Morrow-Tesch², and J. J. McGlone¹, ¹Pork Industry Institute, Texas Tech University, Lubbock, ²USDA-ARS, Lubbock, TX.

Two hundred and six lactating sows and their litters were used to determine the effects of two fender designs (metal vs. wood) and insulation vs. non-insulation inside farrowing huts on the productivity of sows and their litters. All sows were PIC genetic stock, of contemporary age, and fed a completely balanced milo-soy diet. Ambient temperature and relative humidity were recorded every 15 minutes inside eight farrowing huts (four insulated and four non-insulated) from August to November 1999. Litter weight at weaning was heavier ($P < .05$) in metal fender huts than in wooden fender huts (7.8 ± 0.4 and 7.4 ± 0.4 kg). However, neither fender design nor insulation of the farrowing huts affected piglet mortality (17.0 ± 4.2 and 18.0 ± 3.8 %), sow starting weight (259.0 ± 9.5 and 258.7 ± 8.0 kg), or ending weight (240.16 ± 9.4 and 238.7 ± 8.0 kg). Month affected average litter birth weight ($P < .01$), piglet mortality ($P < .01$), number of pigs weaned per litter ($P < .01$), average litter wean weight ($P < .01$), sow starting weight ($P < .01$) and ending weight ($P < .01$). Ambient temperature and relative humidity were lower ($P < .01$) inside the insulated vs. non-insulated farrowing huts. In conclusion, sows in huts with metal fenders weaned a heavier litter than sows in huts with wooden fenders. Insulating the farrowing hut did not have any effect on production. Mortality of piglets decreased and litter weaning weight increased from August to November. Month affected post weaning sow weights with a loss in September and November but a gain in October. Insulating farrowing huts kept the inside of the farrowing hut cooler but did not affect production parameters. The

use of tall fenders attached to farrowing huts gained some production benefits.

Key Words: Production, Fender Design, Insulation

1000 Effects of stocking rate and diet on ground cover, soil-nitrate and sow performance in a sustainable production system. H. A. Rachuonyo*¹, V. G. Allen¹, W. G. Pond², and J. J. McGlone¹, ¹Texas Tech University, Lubbock, ²Cornell University, Ithaca, NY.

Gestating sows (n=126) were randomly assigned to .4-ha paddocks in an outdoor swine production system at a stocking density of 17.3 or 34.6 sows/ha. Sows were fed a conventional diet or one with high levels of lysine. The experiment was conducted over two parities with three replicates each. Each paddock was sub-divided for sampling into 3 sections: 1) near the radial center, 2) the middle region and 3) an outer section. Soil samples (15 cm deep) were taken at the start and at the end of the study from 3 points in each section and were assayed for nitrate-nitrogen (N). Percent ground cover was visually estimated at the start of the trial and every 30 d thereafter until the end of the study. Sow weights were taken at the time of assignment to treatments, when they were moved to farrowing pastures, and at weaning time. Production data included total number of pigs born per sow, number born alive or dead, birth weight, male:female ratio, number weaned, average weaning weights, and mortality. Nitrates were analyzed as a split-plot over time. Performance data were analyzed as a completely randomized design. There was no difference ($P > .05$) in soil N due to either stocking rate or diet. However, ground cover was reduced ($P < .01$) by the higher stocking rate (34.6 sows/ha) at a rate of 14% every 30 d compared with a rate of 5% by the lower stocking rate (17.3 sows/ha). More ($P < .01$) piglets were weaned per sow (8.4 vs $7.1 \pm .34$) from the higher stocking rate. Piglet mortality was higher ($P < .05$) for the lower stocking rate (25.7 vs 18.1 ± 2.2). This study indicated that a stocking rate of 34.6 vs 17.3 sows/ha may have increased production potential but longer-term studies are needed to determine effects on forage and nutrient management.

Key Words: Pig, Diet, Environment

1001 Use of Lutalyse to facilitate the training of boars for semen collection. M.J. Estienne and A.F. Harper*, Virginia Polytechnic Institute and State University, Blacksburg.

The objective was to determine the effects of prostaglandin-F₂alpha (Lutalyse; Pharmacia & Upjohn Company, Kalamazoo, MI) on the training of sexually active boars (i.e., boars experienced with natural mating) to mount an artificial sow for semen collection. Fourteen boars (4 Hampshire, 4 Landrace and 6 Yorkshire) ranging in age from 1 to 4 years were utilized, and treatment groups were balanced for breed and age. Boars were moved to a semen collection pen twice weekly for 4 wk, and training sessions for each boar lasted a maximum of 15 min. Upon entering the collection pen, 7 boars received an i.m. injection of 10 mg Lutalyse and seven control boars received an i.m. injection of 2 ml deionized water. Boars were considered trained when after a successful collection, the animals mounted the artificial sow and allowed semen collection on the next scheduled day without first receiving an injection of Lutalyse or deionized water. Six of 7 Lutalyse-injected boars and 2 of 7 control boars mounted and allowed semen collection during the first exposure to the artificial sow ($P < .03$). After 4 training sessions, 7 of 7 Lutalyse-treated boars and 4 of 7 controls were successfully trained ($P < .05$). At the conclusion of the eighth training session, 3 remaining untrained controls were administered Lutalyse and 2 of the boars mounted the artificial sow and allowed semen collection. Reaction time (interval from entering collection pen to start of ejaculation; 476.2 ± 52.9 s), duration of ejaculation (267.5 ± 24.6 s), semen volume (163.7 ± 12.1 mL), sperm concentration (385.6 ± 28.8 million/mL), and total sperm cells (58.0 ± 5 billion) were similar ($P > .1$) for boars receiving injections of Lutalyse or deionized water and for trained boars receiving no injections. The number of false mounts (mounting artificial sow but not allowing semen collection) was affected ($P < .06$) by treatment and was $1.6 \pm .5$, $4.0 \pm .9$, and 4.2 ± 1.0 for Lutalyse- and deionized water-injected boars, and trained boars receiving no injections, respectively. In conclusion, use of Lutalyse has potential for expediting the training of sexually active boars to mount an artificial sow for semen collection.

Key Words: Prostaglandin, Libido, boar

1002 Developing a method for testing breeding products using data from commercial pig farms. J.W.G.M. Swinkels*¹, G.W.J. Giesen², J.W. van Riel¹, and G.B.C. Backus¹, ¹Research Institute for Pig Husbandry, Rosmalen, The Netherlands, ²Wageningen Agricultural University, The Netherlands.

A total of 438 sow farms and 101 growing-finishing pig farms were used to develop a method for testing of breeding products using data from management information systems (MIS). A breeding product is defined as a combination of one sow- and one boar-line marketed by one breeding company. As part of the quality control of the MIS-data, all pig records were checked. If a single error was found, the entire farm was excluded. Moreover, only farms were used that had a population consisting of 90% or more of one breeding product. On each farm a survey was conducted. Using the survey, over 100 variables were computed to characterize the farm and farmer. From the MIS, 17 and 13 index figures were computed for each sow and growing-finishing pig farm, respectively. For the statistical analyses, 125 sow farms with six different breeding products and 60 growing-finishing pig farms with four different breeding products were used. The minimum number of sow and growing-finishing pig farms per breeding product was 16 and 10, respectively. In sow farms, the overall farm average of the piglets born alive was $10.9 \pm .47$ (mean \pm sd). Corrected for "farm size", "region", "feed company" and some aspects of farmer and management, the maximum difference among the six breeding products was .72 piglets per litter ($P < .01$). Of the 17 index figures, nine were influenced ($P < .05$) by breeding product. In growing-finishing pig farms, the overall farm average of lean meat was $55.4 \pm .43\%$ (mean \pm sd). The maximum (corrected) difference among four breeding products was .7% ($P < .01$). The index figures "type AA+A" and "slaughter weight" were similar for the four breeding products. The other 10 index figures were not analyzed due to the small number of farms per breeding product. In conclusion, a test of pig breeding products can be performed using MIS-data from commercial sow farms. For growing-finishing pigs, the number of farms per breeding product was too low to analyze all index figures.

Key Words: pig breeds, performance testing, farm comparisons

1003 Effect of modifications to pen design formation on the performance of weaned pigs housed in large group systems. P.C. Penny*, JSR Healthbred Ltd, Southburn, UK.

Conventional methods of penning weaned pigs is being overshadowed by the implementation of larger group systems. The objective of this experiment was to determine the effect of pen design modifications on large group pig performance during the first five weeks post weaning. A total of 1170 weaned pigs (JSR Genepacker 90) were used in a randomised block design involving three treatments with 130 pigs per group. Pen design treatments related to control (C) 0.22 m² d 0-35, Design 1 (D1) 0.22 m² d 0-28 and 0.30 m² d 29-35 with feeder allocation in two locations, Design 2 (D2) 0.12 m² d 0-7, 0.22 m² d 8-28 and 0.30 m² d 29-35 with feeder location as C. Feeder allocation was 50 mm/pig and a feeding programme was standardised for all treatments. Pigs were weighed individually at weaning, d 7, 14, 21, 28 and 35. Age at weaning 26 (s.e. 0.08) days, live weight 7.6 (s.e. 0.03) kg. D1 had a significantly higher ($P < .01$) average daily gain (ADG) from d 0-7 (0.188 vs 0.149 vs 0.156 kg) compared to C and D2. Gain / feed (G / F) was improved ($P < .05$) for D1 and D2 during d 0-7 (0.99 vs 0.86 vs 0.78). From d 22-28 D1 achieved a higher ADG ($P < .05$) compared to C and D2. Both D1 and D2 produced a large ADG increase ($P < .001$) between d 28-35 (0.632 vs 0.627 vs 0.552 kg) compared to C. Overall d 0-35, D1 and D2 exhibited a significantly higher ($P < .05$) ADG (0.430 vs 0.418 vs 0.405 kg) and G/F benefit (0.77 vs 0.75 vs 0.71). These results suggest that provision of two feeding locations within a large group system can deliver increased growth opportunities. Improving intra-space distance between pigs during the latter stages of growth provides unrestricted movement, this could be a necessary component for large group functionality.

Key Words: Pigs, Pen Design, Performance

1004 Effect of adjustments to feeding space allocation on pigs provided with a reduced floor space allowance. P.C. Penny* and P.J. Penny, *JSR Healthbred Ltd, Southburn, UK.*

It is clear that a reduction of floor space, usually obtained by increasing pig numbers per pen decreases pig growth, although often other important pen resources such as feeding space are unadjusted. It is hypothesised that by reducing floor space allowance whilst at the same time increasing feeding opportunity will counteract this negative effect and optimise pig performance, the objective of this experiment was to test this hypothesis. A total of three hundred and ninety six (JSR Genepacker 90) grower pigs were used in a randomised block design involving three treatments and six replicates providing 22 pigs per pen. Standard (ST) 0.4 m² + 50 mm of feeding space / pig, Minimum (M) 0.3 m² + 50 mm and Minimum+ (M+) 0.30 m² + 100 mm. Mean start weight of 21.3 (s.e. .11) kg, pigs were weighed on d 14 and 28. All pen dimensions, proportions and design layout were standardised and the experimental period was 28 days. Eleven pigs failed to finish the experiment, these were divided four, five and two between ST, M and M+ respectively. Average daily feed intake (ADFI) d 0-14 was higher (P<.05) for ST than M. Between d 15-28 ST and M+ exhibited an increased (P<.05) average daily gain (ADG) compared to M (0.719, 0.713 vs 0.676 kg), ADFI was also higher for ST (P<.001) and M+ (P<.05) during this growth period (1.395, 1.360 vs 1.287 kg). From d 0-28 ADG was higher (P<.01) for ST than M, but not M+. ADFI from d 0-28 was greater for ST (P<.001) and M+ (P<.05) compared to M (1.149, 1.110 vs 1.075 kg). The coefficient of variation for ADG from d 15-28 and d 0-28 for ST, M and M+ was .23, .24, .19 and .17, .22 and .17 respectively, indicating reduced variation for M+. In conclusion these results confirm that a combination of low floor space allowance and feeding provision, causes a detrimental response to pig growth and feed intake. However, supplementing a reduced floor space allowance with increased feeding opportunities overturns this negative response and can deliver major performance benefits.

Key Words: Pigs, Feeding Space, Performance

1005 Effectiveness of obtaining gilts differing in body composition at farrowing. P.C. Penny*¹ and H.M. Miller², ¹*JSR Healthbred Ltd, Southburn, UK*, ²*University of Leeds, School of Biology, Leeds, UK.*

The aim of this study was to determine whether gilts of the same genotype which are inherently lean or fat at service would remain so through gestation. These gilts could then be used to investigate effects of body type during lactation without utilizing dietary manipulation in gestation and therefore avoid any resultant confounding effects. Three hundred high lean potential gilts (JSR Healthbred) were fed ad libitum from weaning to service. At service and farrowing gilts were weighed and P2 backfat measured 65 mm from the midline over the last rib. From service to farrowing all gilts received 2.5 kg/gilt/d from d 21-90, 3.25 kg/gilt/d from d90 to farrowing. The diet contained 16.0 % CP, .8 % lysine and 3.25 Mcal/kg. At service gilts which had a P2 ≤ 15 mm were classed as lean (Ls) and gilts with a P2 >15 mm were classed as fat (Fs). At farrowing gilts with a P2 =20 mm = Lf and those with P2 >20 mm = Ff. There was no difference in age between Ls (n=149) and Fs (n=151) gilts. Ls gilts were on average 11.8 kg lighter and 7 mm leaner (P<.001) compared to Fs gilts (149.5 vs 161.3 kg and 12.5 vs 19.5 mm). At farrowing 296 of the original 300 gilts remained. From the Ls gilts 63 % continued within the same body type until farrowing, with 36 % of Ls gilts transferring to Ff status. This compared to 98 % for Fs gilts retaining the same body type. At farrowing Lf (n=94) gilts were again both lighter 16.3 kg BW and leaner 9.7 mm (P<.001) than Ff (n=202) gilts. These results suggest that it is possible to select gilts at service on the basis of body type for subsequent experimentation during lactation. However, one third of gilts which achieved lean body composition status at service, changed and became fat at farrowing. This methodology of obtaining gilts of specific body type at farrowing therefore questions the unknown effects that extreme dietary manipulation during gestation could have on lactation and metabolic response.

Key Words: Gilt, Body Composition, Farrowing

1006 Effect of zinc oxide inclusion level on diet selection of weaned pigs. P.C. Penny*¹ and S. Tibble², ¹*JSR Healthbred Ltd, Southburn, UK*, ²*SCA Iberica S.A. Mequinenza, Espana.*

The objective of this study was to investigate the effect of zinc oxide inclusion on the diet selection of pigs post weaning. A total of two hundred and sixty pigs were randomly allotted to one of two experimental treatments. Each treatment utilised four distinct diets A,B,C and D each differing only in nutrient density concentration. These were provided on a choice basis feeding programme as follows, diet A / B from d 0-7, B / C from d 8-14 and C / D from d 15-21 and d 22-28. Zinc 1 (Z1) equated to 3.0 kg of zinc oxide inclusion for diets A+B+C and 0 kg in diet D, Zinc 2 (Z2) had 3.0 kg in diets A+B, 1.5 kg for diet C and 0 kg diet D. From d 0-7 preference for diet A was substantially above that of diet B, 78 vs 22 and 86 vs 14 % for Z1 and Z2 respectively. During d 8-14 pigs on Z1 consumed 57 % of diet B in favour of C, for Z2 the quantity of diet B intake was distinctively lower (P<.01) at 35 % with the remaining 65 % of intake being attributed to the lower density diet C. Diet selection altered for Z1 from d 15-21 with a shift away from diet C opting instead for the lower density diet D, 38 vs 62 %. Z2 continued with the adoption of consuming diet C compared to D, but the movement for Z2 was less distinct 42 vs 58 % than that expressed by Z1. Intake distribution of diets C and D from d 22-28 for Z1 delivered a major reduction of diet C consumption (P<.01) towards a strong preference for diet D, 17 vs 83 % this compared to the transition response of pigs within Z2 treatment 32 vs 68 %. These results demonstrate that when pigs are provided with opportunities of diet selection, careful consideration should be given to zinc oxide inclusion levels within the diets presented.

Key Words: Pigs, Zinc Oxide, Diet Selection

1007 The Growth Performance of the Progeny of Two Sire Lines Reared under Differing Environmental Conditions. D. N. Hamilton*¹, M. Ellis¹, B. F. Wolter¹, N. R. Augspurger¹, F. K. McKeith¹, and E. R. Wilson², ¹*University of Illinois, Urbana*, ²*PIC, Franklin, KY.*

A total of 340 pigs were used in a 2×4×2 factorial arrangement to investigate the effects of and interactions between sire line, rearing environment, and sex on growth performance from 40±1.5 to 120±2.5 kg live weight. Sires from line A (n=8) and line B (n=9) were mated to PIC C22 dams. Line A was of Pietrain ancestry and line B was a synthetic line containing Large White, Landrace, Duroc and Pietrain. Pigs reared in the I environment were kept in individual pens (1.58 m² /pig) and fed an antibiotic at a therapeutic level during the first two weeks of the study. The S environment consisted of groups of 4 pigs with a more than adequate floor space allowance (.93 m²/pig). Pigs grown in the F (FIRE system) environment were housed in groups of 8 with an adequate floor space allowance (.90 m²/pig). C pigs were kept in groups of 12 pigs with a reduced floor space allowance (.37 and .56 m²/pig for the grower and finisher phases, resp.). There were no interactions (P > .05) between sire line and rearing environment for growth performance. Progeny of line A compared to line B pigs grew slower (983 vs. 1044 kg/d, SE=13.4, P<.05), had similar feed intake but a higher gain:feed ratio (.36 vs. .38, SE=.005, P<.05). Pigs reared in environment I grew the fastest and C pigs grew the slowest while F and S pigs were similar (1156 vs. 1019 vs. 981 vs. 898 g/d, SE=18.7, P<.05, for I, F, S and C, resp.). Environment I pigs had the highest feed intake and F and C pigs had the lowest while S pigs were intermediate (3061 vs. 2497 vs. 2813 vs. 2627, g/d, SE=51.5, P<.05, resp.). Animals reared in the F environment had the highest gain:feed while S and C pigs had the lowest (.38 vs. .41 vs. .35 vs. .34, SE=.007, P<.05, for I, F, S and C). Differences between sexes for growth traits were in agreement with previous research. This study suggests that the relative difference in growth performance between these two sire lines was similar across the wide range of environments evaluated.

Key Words: Sire Line, Environment, Growth

1008 The Meat Quality Characteristics of the Progeny of Two Sire Lines Reared under Differing Environmental Conditions. D. N. Hamilton^{*1}, M. Ellis¹, B. F. Wolter¹, F. K. McKeith¹, and E. R. Wilson², ¹*University of Illinois, Urbana*, ²*PIC, Franklin, KY*.

A total of 128 pigs (120 kg) were used in a 2×2×2 factorial arrangement to investigate the effects of and interactions between sire line (A vs. B), environment (spacious vs. crowded), and sex (barrow vs. gilt) on meat quality characteristics. Sires from line A (n=7) and line B (n=8) were mated to PIC C22 dams. Line A was of Pietrain ancestry and line B was a synthetic line containing Large White, Landrace, Duroc and Pietrain. All male and female parents were from lines that had been tested as free of the detrimental allele of both the Halothane and RN genes. Pigs in the spacious environment (S) were kept in groups of 4 animals with a more than adequate floor-space allowance (.93 m²/pig). Pigs in the crowded environment (C) were kept in larger groups of 12 pigs and with a reduced floor-space allowance (.37 and .56 m²/pig for the grower and finisher phases, resp.). Line A compared to line B pigs had poorer longissimus meat quality, having lower ultimate pH (5.43 vs. 5.48, SE=.018, P<.05), subjective color scores (2.0 vs. 2.5, SE=.11, P<.05), subjective firmness (2.0 vs. 2.4, SE=.12, P<.05) subjective marbling (1.9 vs. 2.3, SE=.13, P<.05), indicating paler, softer meat with less marbling, and higher L* (49.37 vs. 47.42, SE=.647, P<.05). Animals reared in the C compared to the S environment had lower longissimus L* values indicating darker muscle (47.17 vs. 49.61, SE=.643, P<.05). A genotype × environment interaction was found for drip loss. Line B pigs had lower drip loss in the C compared to the S environment (4.46 vs. 6.69 %, resp., SE=.616, P<.05); there was little difference for drip loss in the two environments (6.96 vs. 7.29 %, resp., SE=.616, P<.05). This study highlights the effect of genotype on meat quality but shows that the two environments used had limited impact on pork quality.

Key Words: Sire Line, Environment, Meat Quality

1009 Effect of split-weaning on sow and piglet performance. G. E. Bressen^{*}, S. W. Kim, and R. A. Easter, *University of Illinois, Urbana*.

Twenty-eight primiparous sows and litters were used to study the effect of split-weaning on sow and piglet performance. Sows were fed ad libitum during the 21 d lactation and litter size was set to 10 pigs by cross-fostering as needed within 48 h of farrowing. Feed intake of sows and body weights of sows and nursing pigs were recorded weekly. Backfat thickness (10th rib) of sows was recorded on d 109 of gestation and d 21 of lactation. Sows were separated into two groups of fourteen sows. Litters from the first group of fourteen sows (control) were weaned on d 21 of lactation. On d 14, the five heaviest (H) pigs (avg 4.34 kg body weight) from each sow in the second group (split-weaned) were weaned leaving the five lightest (L) (avg 3.46 kg body weight) to suckle for an additional 7 d. Conventional and split-weaned sows had similar body weights at d 1, 7, and 14, but the sows from the split-weaned group were heavier (P < .05) at d 21 of lactation. Total body weight loss during d 1 to 21 of lactation was greater for control sows (P < .07) than split-weaned sows. The back fat loss was greater (P < .1) in control sows (2.13 mm) than in split-weaned sows (.45 mm) during 21-d lactation. Average daily gains of heavy piglets (220 g) from split-weaned litters were greater (P<.05) than those pigs (196 g) left on the sow for the entire lactation period. More importantly light pigs exhibited similar (P > .07) average daily gains (187 g), when compared to heavy pigs (196 g) left on the sow for the whole lactation period. This study suggests that split-weaning will reduce sow body weight loss while maximizing total litter performance.

Key Words: Sows, Split-weaning, Litter growth

1010 Effects of a polyaspartate biopolymer (PAB) on growth performance of weanling pigs. A.F. Harper^{*} and M.J. Estienne, *Virginia Polytechnic Institute and State University, Blacksburg*.

The potential for development of resistant microbes and regulatory concerns may force reduced use of antibacterial feed additives and increases the need for non-antibacterial growth promoters. The objective of this experiment was to determine the effects of dietary inclusion of PAB (Donlar DXL590; Donlar Life Sciences, Bedford Park, IL) on the performance of nursery pigs. Crossbred pigs (Yorkshire x Landrace and

Yorkshire x Landrace x Hampshire), 17 to 24 d of age and 7.7 kg BW, were weaned and assigned to one of four dietary treatments which included PAB inclusion rates of 0 (control), 100, 200, or 400 ppm. There were 6 replicate pens of 4 pigs each per treatment (96 pigs total; 24 pigs per treatment). Diet nutrient density was adjusted in 3 phases to meet NRC (1998) requirements over the 5-wk trial and feed and water were available ad libitum. Pig BW and pen feed consumption were determined weekly. There were no effects (P > .1) of PAB on any measure of pig performance at any point during the experiment. For the entire trial, growth rate (kg/d), feed consumption (kg/d) and feed conversion efficiency (feed/gain), were similar (P > .1) for controls (.50±.02, .83±.04, and 1.65±.05, respectively) and pigs receiving 100 ppm (.50±.01, .84±.04, and 1.70±.05, respectively), 200 ppm (.49±.01, .83±.02, and 1.68±.04, respectively), or 400 ppm (.51±.02, .87±.04, and 1.70±.05, respectively) PAB. Weekly stool evaluations (1 to 5; 1 = very firm feces and 5 = very loose, watery feces) were conducted to assess the incidence and severity of scouring. Overall fecal scores were similar (P > .1) between groups and for the entire five week trial were 3.1±.09, 3.2±.1, 3.1±.08, and 3.1±.1 for controls, and pigs receiving 100, 200 or 400 ppm PAB, respectively. Under the conditions of this experiment, there were no effects of the Donlar DXL590 polyaspartate biopolymer on performance of nursery pigs.

Key Words: Growth Performance, Polyaspartate Biopolymer, Pigs

1011 Effects of Acclimate on the incidence of aggression and growth performance in weaned pigs. M. Amstutz^{*}, K. Bennett-Wimbush, T. Meek, and S. Courtney, *The Ohio State University Agricultural Technical Institute, Wooster*.

Newly weaned pigs often exhibit aggressive behavior which can result in injury, reduced performance, and in severe instances death. This experiment was designed to determine the effect of Acclimate (Exodus Breeders Supply, Ltd., York, PA.), a product reported to reduce equine aggression, on weaned pig aggression and growth performance. Eighty-two weaned pigs (avg. wt. 6.25 kg) were blocked by sex, weight, and litter and randomly assigned to either an Acclimate treatment or control group. Groups consisted of 11-12 pigs each and were housed on 4 x 8' raised nursery decks. Pigs in the treatment group were marked with Acclimate on the nose, face, and neck at weaning. All pigs were uniquely identified and videotaped for two hours post weaning. The incidence of aggression (IOA) was determined on an individual pig basis for the two hour period following weaning. Individual pig weights and pen feed consumption were used to determine feed intake (FI), total weight gain (TWG), average daily gain (ADG), and gain to feed ratio (G/F) over a seven day period. Differences between litter, sex, and treatment for IOA and TWG were tested using GLM, SAS at a p < 0.05 significance level. Neither Acclimate treatment of weaned pigs nor sex had a significant effect on IOA or TWG. However, there was a trend toward decreased IOA with Acclimate treated pigs (LS mean: control 4.9 \bar{n} 0.8, Acclimate 3.5 \bar{n} 0.8) which seemed to be accompanied by a decrease in the intensity of aggression. It should be noted that considerable variability in the IOA was observed between individual pigs and between replicates. TWG for the seven day period was 1.20 and 1.29 kg for control and Acclimate treated pigs respectively. Pig litter did effect IOA and TWG (p < 0.001). These preliminary results suggest that Acclimate treatment of weaned pigs does not decrease the IOA, but may decrease the intensity of aggression without negatively effecting growth.

Key Words: Pig, Aggression, Behavior

1012 The feed intake behavior of the progeny of two sire lines monitored by a computerized feed intake recording system. N. R. Augspurger^{*1}, M. Ellis¹, D. N. Hamilton¹, B. F. Wolter¹, J. L. Beverly¹, and E. R. Wilson², ¹*University of Illinois, Urbana-Champaign*, ²*PIC, USA, Franklin, KY*.

Forty-eight pigs were used in a completely randomized design with a 2 × 2 factorial arrangement of treatments to investigate the effect of sire line and sex on feed intake behavior of growing-finishing pigs. Sire line A was of Pietrain ancestry and sire line B was a synthetic line comprised of Large White, Landrace, Duroc, and Pietrain. Sires from Line A (n=8) and Line B (n=9) were mated with PIC Camborough 22 females. Growth performance and feed intake behavior of the progeny were measured from 40.2 \bar{n} 2.04 kg to 120.0 \bar{n} 2.85 kg BW. Pigs were housed in groups of eight with two pigs from each each line × sex subclass. The floor space allowance was .9 m² /pig. Feed intake behavior was

monitored by a computerized feed intake recording system (F.I.R.E., Osborne, KS). Pigs were allowed a one-week acclimation period prior to the start of the study. Line B progeny grew faster (1042 vs 960 g/d, SE=18.4, $P<.01$), had a higher daily feed intake (2604 vs 2432 g/d, SE=51.7, $P<.05$), but a similar gain to feed ratio compared to the progeny of line A. Line B pigs tended to visit the feeder less often (13.4 vs 15.5, SE=.81, $P<.10$), but consumed more feed per visit (213 vs 177 g, SE=10.2, $P<.05$), and had a faster consumption rate (36.8 vs 29.8 g/min, SE=2.02, $P<.05$) than Line A pigs. There were no differences between the two lines for feeder occupation time per visit or per day. Castrates grew faster ($P<.01$), consumed more feed ($P<.001$), and were less efficient ($P<.01$) than gilts, but there were no differences between the sexes for any of the feed intake traits. Feed intake behavior showed significant changes with increasing pig live weight between the live weight ranges 40 to 80 kg and 80 to 120 kg: number of feeder visits and feeder occupation time per visit and per day decreased, and feed intake per visit and feed consumption rate increased with increasing pig live weight. The results of this study illustrate the influence of genetics and, particularly, live weight on feeding behavior in growing-finishing pigs.

Key Words: Sire Line, Sex, Feed Intake Pattern

1013 Effect of oil spraying on dust reduction and on subsequent pig performance. B. K. Anderson*, X. Wang, M. Ellis, and G. Riskowski, *University of Illinois, Urbana.*

In a series of five 28 day trials, a total of 688 finishing pigs with an average starting weight of 77.31 ± 1.15 kg were used to determine the efficacy of oil spraying as a measure of dust reduction and to evaluate the subsequent pig performance. Pigs were blocked by weight and allotted to treatment by sex and ancestry. Pigs were housed in identical rooms within industry similar facilities at a stocking density of .95 m²/pig. Pigs were housed in two buildings on the Moorman Swine Research Farm at the University of Illinois. Pigs were offered ad libitum access to stock diets for the entire four week experimental period. Diets were formulated to meet or exceed NRC (1998) requirements. Soybean oil was applied daily to the pen surfaces through use of a hand-held applicator. The applicator was calibrated to dispense exact levels of oil. The oil was applied to the surface of both the pen and pigs, attention was taken to not spray the fencing or feeders. Oil was applied daily between the hours of 0800 and 1000. The oil was applied in a predetermined schedule where days 1-2 received 40 ml/m², days 3-4 received 20 ml/m², and days 5-28 received 15 ml/m². Pigs were weighed and feed disappearance was recorded every two weeks for the determination of average daily gain and feed efficiency. Dust mass samples were taken weekly by drawing air through a 37 mm diameter Millipore filter (0.8 um pore size) for 24 h in the center of the alley at a height of 5 ft. Filters were dried in a desiccant drier for 24 h, then weighed on a precision electronic balance prior to and following sampling for determination of dust mass. Dust mass concentration was reduced by an average of 57% across the five trials with a maximum and minimum reduction of 64 and 47% respectively. Oil spraying did not have an effect on average daily gain, feed intake or gain:feed. Therefore, results of this study indicate that oil spraying is effective in reducing dust without affecting animal performance.

Key Words: Pigs, Dust, Performance

1014 Effect of varying the amount of potato chip scraps in the diet of pigs at different stages of growth on their performance. S. Rahnema* and R. Borton, *Ohio State University, Agricultural Technical Institute, Wooster.*

An experiment was conducted to determine the effect of changing the amount of potato chip scraps (PCS) at different stages of growth on dry matter intake (DMI), total gain (TG), average daily gain (ADG), and gain to feed ratio (G:F) of swine. Pigs ($n = 176$, avg wt 8.63 ± 1.15 kg) were stratified by sex and weight and used in a randomized complete block design experiment with four treatments in four blocks. Each treatment consisted of four pens of 10 or 12 pigs each. In treatment one (control), pigs were fed a corn and soybean meal-based diet supplemented to meet NRC requirements. In treatments two, three, and four, 10%, 12.5%, and 20% of the corn, respectively, was replaced with 10%, 12.5%, and 20% of PCS. The level of PCS in the control (none) and 12.5% PCS diets was kept unchanged throughout the experiment. However, the level of PCS in the 10% diet was increased to 15 and then

20% and the 20% PCS diet was lowered to 15 and then 10% at the growing and finishing stages, respectively. Changing the levels of PCS during different stages of growth had no effect on TG ($P = .77$) or the G:F ($P = .23$). However, DMI tended to be lower ($P<.09$) for pigs on the 12.5% PCS vs the control and 20% PCS diets. Also, the ADG for pigs that were initially started on the 20% PCS diet was lower ($P = .01$) than the other three treatments. The number of days needed to reach market weight were 128, 133, 128, and 143 for pigs on the control, 10, 12.5 and 20% PCS diets, respectively. Of the carcass characteristics and organoleptic factors studied in this experiment, only juiciness and overall ratings for chops from pigs on the 12.5% PCS diet were rated lower than the control and 10% PCS. This experiment demonstrates that there was no advantage in increasing or decreasing the level of PCS at different stages of growth over the control or continuous feeding of 12.5% PCS in the diet of pigs.

Key Words: Potato Chips, Pig Performance, Carcass Characteristics

1015 Effect of chromium methionine supplementation on egg hatching response of Japanese quail under controlled temperature condition in dry tropic weather. G. Contreras*, R. Barajas, and A. Montoya, *Universidad Autonoma de Sinaloa.*

To determine the effect of chromium methionine supplementation, on hatching egg production response of Japanese quail under weather controlled condition (25°C) in dry tropic, one all randomized design experiment was conducted, 320 Japanese quail (240 females and 80 males) were divided in 40 groups of eight avian (six females and two males), each group of eight quails was allocated in a metal wire crate (25 x 30 cm), including as part of a battery of crates with five levels and four crates by levels (20 crates), each battery level (32 quails) was considered as an observation, and were randomly assigned to consume one of two experimental diets in that consist the treatments: 1) Diet containing 21% CP and 2.9 Mcal ME/kg (control); and 2) Diet similar to control, supplemented with 200 ppb of Cr from chromium methionine (Met-Cr). Chromium methionine supplementation, increased ($P<0.01$) in 32.8% the average daily egg production (64.14 vs 87.85%) and percent of egg production (55.12 vs 73.21%). Met-Cr improved ($P<0.01$) in 56.3% the average of daily hatching egg production (39.4 vs 61.6), and in 17.7% the percent of hatching egg (59.7 vs 70.1%). Daily feed intake was augmented ($P<0.01$) in 8.3% by Met-Cr supplementation (5.32 vs 5.76 g/d). The long, wide, and weight of eggs were not effected by treatments. The index feed intake/egg production was diminished in 11.1% by Met-Cr treatment (0.648 vs 0.576). It is concluded, that chromium methionine supplementation improve the production of egg and hatching egg in Japanese quail under weather controlled condition in dry tropic areas.

Key Words: Chromium, Japanese quail, Hatching

1016 Effect of supplementation in drinking water with two organic chromium sources on blood glucose level and weight gain of Japanese quail (*Coturnix coturnix japonica*) in their first week of live. G. Contreras*, N. Montesinos, and R. Barajas, *Universidad Autonoma de Sinaloa.*

To determine the effect of supplementation in drinking water of chromium picolinate (Pic-Cr) or chromium methionine (Met-Cr) on blood glucose level and weight gain of Japanese quail in their first week of live. Five hundred Japanese quail (*Coturnix coturnix japonica*) was used in a randomized design experiment. The animals were distributed in twenty five groups of 20 quail. Each five group was randomly assigned to one of the next treatments: 1) Regular management without supplement in water (control); 2) Drinking water with supplemented with 100 ppb of Cr from Pic-Cr; 3) Drinking water with 200 ppb of Cr from Pic-Cr; 4) Drinking water supplemented with 100 ppb of Cr from Met-Cr; and 5) Water supplemented with 200 ppb of Cr from Met-Cr. Mean of experiment mortality was 1.2% and was not affected ($P>0.10$) by treatments. Treatment with 200 ppb of Cr from Met-Cr, increased ($P<0.01$) blood glucose (236.6 vs 299.8 mg/dL) and improve ($P<0.05$) final weight (36.93 vs 37.47 g) and weight gain (27.7 vs 29.12 g). Met-Cr inclusion in drinking water with independence of used level, increased 26% ($P<0.01$) blood glucose concentration (236.6 vs 297.9 mg/dL) and tended to increase ($P=0.07$) in 2.8% body weight (36.93 vs 37.97 g), and tended to improve ($P=0.10$) in 3.6% weight gain (27.7 vs 28.7 g). Pic-Cr had not effect ($P>0.10$) on the variables. It is concluded that, chromium

supplementation in drinking water not affect the mortality of Japanese quail in trial in they first living week, and the inclusion of 200 ppb of chromium from chromium methionine increased blood glucose levels and weight gain.

Key Words: Chromium methionine, Picolinate, Japanese quail

1017 Dairy business analysis project: 1998 performance summary. M. J. Hoekema¹, R. Giesy¹, M. Sowerby¹, T. Seawright¹, P. Miller¹, A. Andreasen¹, C. Vann¹, and L. O. Ely*², ¹University of Florida, Gainesville, ²University of Georgia, Athens.

The dairy business analysis project was initiated to measure and document the financial performance of dairy businesses using standardized accounting measures so that uniform comparisons could be made among participants. Increased participation has allowed several comparisons to be made. Georgia and Florida comparisons were made this year. Florida dairies averaged \$19.59/cwt income compared to Georgia dairies income of \$18.67/cwt. Expenses were \$17.65 for Florida and \$17.24 for Georgia resulting in net farm income (NFI) of \$1.94 for Florida and \$1.44 for Georgia. Bst usage was sorted for no use, 0-15 doses /cow and >15 doses/cow resulting in NFI of \$1.62, \$1.91 and \$2.09. Heifer raising was sorted for <.3, .3-.6 and >.6 heifers per cow resulting in NFI of \$2.73, \$1.61 and \$1.38. Farms were sorted on feeding system: mixed ration-no crops, mixed ration- cropping, one-shot and partial grazing resulting in NFI of \$1.64, \$1.24, \$2.11 and \$3.97. The data was also sorted for herd size, level of production, milk sold per worker and frequency of milking.

Key Words: financial data

1018 Producing milk economically in Quebec by increasing forages in dairy cow rations. K. Valiquette*¹, D.G. Pellerin¹, G. Allard¹, D. Lefebvre², L.P. Vezina³, P. Paquin¹, and D. Pellerin¹, ¹Universite Laval, ²PATLQ inc., ³Agriculture and Agri-Food Canada.

In Eastern Canada good quality forages can be grown economically. Increasing the proportion of forages in dairy cow rations should lead to a decrease in milk production cost. The AGRITEL data base was used to select farms based on their milk production allowed by forages, half with a low (LF) and half with a high milk (HF) from forages. Data from those farms were collected over two production years (05-96 to 06-98). Herd size was similar for both farm groups, averaging 46 milking cows. Average milk yield was also similar at 7 221 kg per cow. Milk protein at 3.29% as well as milk fat at 3.96% (HF 3.97 % and LF 3.94%) did not differ between the two farm groups. Cows weighed 18 kg less on the HF farms (P<0.01). Farms feeding more forages also cultivated more land in forages resulting in lower ratios of cows per ha grown in forages, HF 0.92 and LF 1.23 (P<0.001). Based on the proportion of forages and concentrates in cow rations, it was calculated that 2 935 kg of the milk produced on HF farms could be associated to forage intake compared with 1 533 kg of milk on LF farms (P<0.001). Milk production gave an overall ratio of 3.16 kg of milk per kg of concentrate for the HF farms compared to 2.35 for the LF farms (P<0.001). Feeding cost per hL of milk produced was \$2.54 cheaper on HF farms than on LF farms (\$8.63 Vs \$11.17, P<0.0001). This reduction in feeding cost was also associated with a decrease in veterinary costs of \$0.24 per hL (P<0.01) suggesting that cows fed more forage were in better health. Overall the standardized work income per hL was significantly higher on HF farms compare to LF farms (\$9.65 Vs \$6.86, P<0.01).

Results suggest that, in Eastern Canada, increasing the proportion of forages in dairy cow rations could produce milk more economically. Furthermore this approach is environmentally sound as well as providing producers with a better remuneration for their work.

Key Words: high Forage rations, Dairy cattle, feeding Costs

1019 Impact of improving environmental conditions during milking time on milk production. S. Pietrosoli*¹, J. Cubillan, and A. Del Villar, ¹Facultad de Agronomia. La Universidad del Zulia. Venezuela.

In a six-month trial, twelve cross breed Brown Swiss x Cebu cows were used in order to evaluate the effect of improving the environmental conditions during milking time on milk production. The trial was performed in a commercial farm located south of Maracaibo's Lake, Venezuela, in a sub humid tropical forest. Animal grazed tropical grasses: *Brachiaria*

brizantha, *Cynodon nlemfuensis*, *Echinochloa polystachia* and *Panicum maximum*, and were supplemented with mineral salts and molasses *ad libitum*. All the animals were similar in weight, age, lactation period and numbers of calving. Blocks were conformed using average milk production before trial as parameter. A switch back design with two treatments was used, considering residual effect. Treatment 1 **T1** was traditional milking system, using calve to stimulate milking. Treatment 2 **T2** was **T1** + improved environmental conditions: five km/h wind produced by fans and one minute water shower every half an hour, during four hour afternoon milking time. Information was analyzed using GLM procedures of Statistical Analysis System. Milk average was 6.06 lt/cow/day. Statistical differences (P ≤ 0,0001) were detected between treatments. Total milk production of **T2** was 8,34 % higher than **T1**. It was concluded that improving environmental conditions during milking time enhance milk production of grazing cows.

Key Words: Environmental conditions, Grazing cows, Milk production

1020 The effects of six times a day milking in early lactation on milk yield, milk composition, body condition, and reproduction. A. H. Sanders*¹, M. A. Varner¹, and R. E. Erdman¹, ¹University of Maryland, College Park.

Seventy-four cows on a large commercial dairy were selected at calving and assigned to one of three groups 1) milked three times a day (3X) control, 2) milked six times a day (6X) treatment, 3) milked 3X herd cohorts. The treatment period was the first 42 days postpartum, after which all cows were milked 3X. Daily milk yield was recorded for 38 weeks. During weeks 2 through 14, weekly samples were analyzed for fat, protein, and somatic cell count (SCC), and body condition was monitored for treatment and control groups. Cows in the control and treatment groups were bred by artificial insemination at 69 to 76 days postpartum following ovulation synchronization. Pregnancies were confirmed by ultrasound at least 26 days after insemination, cows observed returning to estrus were assumed not to be pregnant. Data was analyzed by analysis of variance using the Mixed procedure of SAS[®] with a least squares model which accounted for treatment group, week postpartum, parity, and all possible interactions, randomized for cow within treatment group. Previous adjusted lactation record was used as a covariate for milk yield. Average daily milk yield was highest for all cows milked 6X, although this difference was not significant. For multiparous cows, those milked 6X (41.1 kg/d, SEM = 1.12) produced more milk than those in the control group (38.2 kg/d, p<0.01) and cohorts (37.9 kg/d, p<0.05). Fat percent was not significantly affected by treatment, but fat yield for multiparous cows milked 6X was 0.13 kg/d (SEM = .05) higher (p<0.01) than 3X controls (1.61 and 1.48 respectively). While percentage protein was lower (p<0.05) for multiparous cows milked 6X (2.87%) than 3X controls (2.98%), protein yield was 0.12 kg/d higher (SEM = .04, p<0.01). There was no significant difference in conception rate between cows milked 6x and controls (31.0%, and 23.3% respectively). There were no significant differences in SCC. Body condition was not affected by treatment. Milking cows six times daily in early lactation may be an effective way of increasing milk yield, without negatively impacting milk quality or cow health.

Key Words: Milking frequency, Production, Reproduction

1021 Relationship between milk and plasma urea nitrogen concentrations and feeding time. E.E. Ferdinand*¹, J.E. Shirley, M.J. Meyer, A.F. Park, M.J. VanBaale, and E.C. Titgemeyer, Kansas State University, Manhattan.

Eight Holstein cows were used to determine the relationship between milk urea nitrogen (MUN), plasma urea nitrogen (PUN), and feeding time. We first established that MUN was similar (P>.05) among quarters by comparing milk samples from each quarter just prior to milking. In order to determine if collecting a sample of milk from a quarter influences the MUN in samples taken later, samples were obtained from the right front quarter (RF) at 2, 4, 6, and 8 h after the a.m. milking and from the left front quarter (LF), right rear (RR), and left rear (LR) at 4, 6, and 8 h after the a.m. milking, respectively. MUN in samples obtained from RF at 4 h was lower (P<.01) than corresponding samples taken from LF, but samples from RF at 6 and 8 h did not differ from corresponding samples obtained from RR and LR. We concluded that by 6 h the effect of previous milking on MUN concentration disappeared because of dilution. To determine the influence of feeding time on MUN concentrations, cows were fed half of their normal p.m. feeding, injected

with oxytocin at the subsequent a.m. milking to reduce residual milk and offered surplus feed after the a.m. milking. Milk samples were collected at 2, 4, 6, 8, 10, and 12 h after feeding from RF, LF, RR, LF, RF, and LF quarters, respectively. Blood samples were obtained from the coccygeal vein at hourly intervals after feeding with the last sample collected 12 h after feeding. MUN in samples obtained at 2, 4, 6, and 8 h was similar. MUN at 10 h was similar to that at 2 and 8 h, lower ($P < .05$) than that at 4 and 6 h and higher ($P < .05$) than that for the 12 h sample. PUN peaked at 2 h post feeding then gradually declined through 12 h post feeding. MUN peaked at 6 h post feeding then declined. Time after feeding significantly influenced PUN and MUN concentrations.

Key Words: MUN, PUN, Dairy

1022 Measurement of critical collapse pressure difference and touch point pressure difference using various milking machine liners. J. S. Kikta^{*1} and S. B. Spencer², ¹John Kikta, Dairy Consultant, ²Spencer Consulting.

Critical collapse pressure difference is the pressure difference between atmospheric pressure and the pressure in the pulsation chamber at the point where the first movement in the liner wall from the fully open position is detected. The touch point pressure difference is also the pressure difference between atmospheric and the pulsation chamber pressure, but at the point where the walls of the liner first make contact as they move toward the fully closed position. Critical collapse pressure difference and touch point pressure difference were measured on three of each of the milking machine liner types. Liners were mounted in an appropriate shell and placed over a light source. The pulsation chamber was then gradually pressurized using a vacuum/pressure pump. The pressure difference was measured using a mercury column at the critical collapse point and the touch point as determined by visual inspection. The results of the test were analyzed using a two-way Analysis of Variance. Critical collapse pressure difference and touch point pressure difference were significantly ($P < 0.05$) different by milking liner type. Least Square means of critical collapse pressure difference and touch point pressure difference ranged from 2 kPa to 11 kPa and 12.5 kPa to 19 kPa, respectively. The Least Square means for touch point pressure difference had a bimodal distribution. Liners with a non-round barrel shape had low critical collapse pressure differences.

Key Words: milking machine liner, touch point pressure difference, critical collapse pressure difference

1023 Clinical and sub-clinical mastitis in cows fed monensin. J.I.D. Wilkinson*, H.B. Green, J.T. Symanowski, D.G. McClary, J.R. Wagner, J.S. Davis, and M.R. Himstedt, *Elanco Animal Health, Greenfield, IN.*

Holstein cows (342 primiparous and 598 multiparous) were fed 0, 8, 16 or 24 ppm monensin in total mixed rations (dry matter basis), using a randomized complete block design over nine locations. Treatment began 21d before expected parturition and continued through lactation (L1), the dry period and subsequent calving. Clinical mastitis and antibiotic therapy were recorded. Somatic cells counts (SCC) were determined on weekly milk samples. At three locations, 249 cows continued the same treatments for 200d of the subsequent lactation (L2). At these sites quarter milk samples were cultured after each calving, at dry-off, and at the end of the study (event samples), and at approximately 56d intervals (calendar samples). Monensin had no effect on the incidence of clinical mastitis in L1. In L2, the animal rate for clinical mastitis in the 24 ppm group was lower than controls and there was a linear trend across doses for reduced mastitis. Mean SCC was higher in the 8 ppm group than controls in L1, but there was no linear trend and there were no treatment effects in L2. Approximately 10% of samples monitored for sub-clinical infection cultured positive. Animal and quarter prevalences were similar across dose levels for both event and calendar sampling schedules. Monensin did not adversely affect the susceptibility of cows to clinical or sub-clinical mastitis, or the frequency with which antibiotics were used to treat mastitis.

Parameter	0 ppm	Monensin 8 ppm	in ration 16 ppm	24 ppm
Clinical mastitis in L1				
Animal rate	0.463	0.435	0.400	0.420
Quarter rate	0.190	0.187	0.167	0.180
Cases/1000 quarter days-at-risk	0.862	0.837	0.722	0.748
Clinical Mastitis in L2				
Animal rate [#]	0.607	0.502	0.479	0.427*
Quarter rate	0.284	0.229	0.221	0.195
Cases/1000 quarter days-at-risk	1.894	1.689	2.014	1.531
SCC 1,000				
L1	74.3	88.1*	80.8	74.3
L2	84.0	97.1	95.1	65.7
Sub-clinical mastitis, % positive (n)				
Event samples	10.0(1101)	10.6(1104)	9.8(1087)	8.9(1097)
Calendar samples	10.1(2655)	10.4(2815)	10.7(2711)	9.4(2800)

[#]P<0.1 for linear trend. *P<0.1 vs control.

Key Words: Monensin, Mastitis

1024 Environmental effects on somatic cell count in Holstein cows from Parana State, Brazil. A. Ostrensky¹, N.P. Ribas¹, H.G. Monardes², R. Almeida^{*1}, D.R. Veiga³, and J.A. Horst³, ¹Universidade Federal do Parana, Curitiba - PR, Brazil, ²McGill University, Montreal, Canada, ³Assoc. Paranaense Criadores Bov. Raca Holandesa, Curitiba - PR, Brazil.

Somatic cell count (SCC) indicates the presence of intramammary infection in cows. So it may be used on mastitis control, on payment systems based on milk quality and on udder health diagnosis. The goal of this study was to evaluate the effects of some environmental factors on milk SCC, on somatic cell score (SCS) and on somatic cell logarithmic transformation (SCL). A data set containing 640,937 monthly test-day records from 40,333 Holstein cows distributed in 378 supervised herds from Holstein Association from Parana State, Brazil, covering a period from January 1994 to December 1998 was analyzed. General Linear Model procedures (SAS, v. 6.12, 1991) were used for the study of the following fixed effects: age of cow at calving, calving season, month-year of test, days in milk, milking frequency and age of the sample. Means and standard deviations of SCC, SCS and SCL were 556,626 835,004 cells/ml, 4.461 1.789 and 8.105 1.789, respectively. All the factors included in the model had a highly significant ($P < 0.01$) effect on the three traits analyzed, except calving season on SCC and milking frequency on all three traits. The trends suggest a steady improvement on the somatic cell count with time. It was also observed clearer results from the two transformed traits (SCS and SCL) than from SCC. [®] ± ± ±

Key Words: Somatic cell count, Somatic cell score, Environmental factors

1025 Transition management: Effect of a post-calving drench (RumenKickstart[®]) on feed intake and milk production in primiparous Holstein/Friesian cows. R. H. Phipps* and D.E. Beever, *Centre for Dairy Research, Department of Agriculture, The University of Reading, UK.*

For three weeks prior to calving 30 primiparous Holstein-Friesian cows received a TMR containing on a DM basis 45% grass silage, 15% maize silage, 25% barley straw, 6% soybean meal, 4% molassed sugar beet feed and 1% minerals. The CP, NDF, starch and ME contents of this ration was 10.3 45.4, 12.9% DM and 11.0 MJ/kg DM. At calving all heifers received a TMR containing 42% maize silage, 14% grass silage, and 46% concentrate, and had CP, NDF, starch and ME values of 20.7, 29.9, 23.0% DM and 12.1 MJ/kg DM. Heifers were randomly allocated at calving to either a treated (T) or control (C) group. Heifers in group T received within 24 h after calving 30 l of lukewarm water containing 500 ml of 1,2 mono-propylene glycol and other ingredients including calcium, sodium, copper, vitamins A, D3 and E, yeasts, plant extracts, selected amino acids, electrolytes and enzymes. During the first five weeks of lactation when individual intakes were recorded there was a small positive

but non-significant mean increase of 0.6 kg DM/d in favour of group T. However at week 2, treatment increased ($P<0.01$) DM intake from 9.5 to 10.9 (s.e.m 0.56)kg/d. During the first five weeks of lactation milk yields for group T were increased ($P<0.05$) from 19.2 to 21.8 (s.e.m 0.81) kg/d. After week 5 of lactation, heifers were group fed, but still milk recorded. Analysis of the milk records between weeks 2-20 of lactation showed that the treated heifers produced a total of 3486 kg milk (27.7 kg/d) compared with 3176 kg milk (25.2 kg/d) (s.e.m. 94.7) for the control group. This difference was significant ($P<0.05$). Milk quality was not recorded. The results show that the drench increased both feed intake and milk production in early lactation and that the initial increase in milk production was sustained for at least 20 weeks.

Key Words: Transition management, Rumen drench, Milk production

1026 Influence of late lactation protein supplementation on full lactation productive and reproductive performance of Holstein cows. P.H. Robinson^{*1}, J.M. Moorby², M. Arana³, R. Hinders⁴, T. Graham⁵, L. Castelanelli⁶, and N. Barney⁷, ¹UCCE, Davis, CA, ²IGER, Aberystwyth, UK, ³UCCE, Stockton, CA, ⁴Hinders Nutr. Cons., Acampo, CA, ⁵Graham & Assoc., Davis, CA, ⁶Castelanelli Dairy, Lodi, CA, ⁷Lignotech USA, Overland Park, KS.

Recent studies report increased CP levels of the close-up dry cow ration, to about 15% DM, improve lactation performance of dairy cows. Holstein cows were assigned to close-up groups that were offered 1) Control, C: 10.8% CP ration based on corn silage, alfalfa cubes, oat hay, corn and barley grain, or 2) Supplemented, S: 13.4% CP as C plus .8 kg/d per cow of a supplement (60% SoyPass[®], 40% others). Heifers (C, 37; S, 43) and mature cows (C, 79; S, 81) were used. After calving, treatment with BSt, movement through production groups, and reproduction were determined by the herd manager. Production parameters were pooled to means for cows that completed the lactation (others were excluded) and analyzed by ANOVA. Time close-up varied (1-19 d), so cows were allotted to 4 time groups for linear regression. As their time in the close-up group increased, primiparous cows on treatment S produced more milk (C: .15 kg/d and S: .29 kg/d per d close-up; $P=.26$ and $.06$), more milk protein (C: 2.1 g/d and S: 7.3 g/d per d close-up; $P=.69$ and $.06$), days in milk (DIM) at BSt start increased for both (C: 1.74 d and S: 1.59 d per d close-up; $P=.09$ and $.11$), DIM at BSt end increased for S cows (C: 1.30 d and S: 2.47 d per d close-up; $P=.22$ and $.04$) and lactation length increased for both (C: .76 d and .92 d per d close-up; $P=.03$ and $.01$). As time close-up increased, mature cows on either CP ration produced more milk fat (C: 8.7 g/d and S: 8.7 g/d per d close-up; $P=.01$ both), increased days at 1st conception (C: 1.35 d and S: 1.37 d per d close-up; $P=.10$ both) and services per conception (C: .054 and S: .048 d per d close-up; $P=.06$ and $.08$). Body condition and locomotion scores, and time in production groups were not affected by CP or time close-up for either parity. Results suggest increasing close-up CP from 10.8 to 13.4% only enhanced productive performance of primiparous cows with little effect on reproductive performance on cows of either parity. Increased time close-up enhanced productive performance regardless of CP or parity, but reduced reproductive performance of mature cows.

Key Words: Dry Cows, Close-up, Transition

1027 Intestinal disappearance, mesenteric and portal appearance of amino acids (AA) in dairy cows fed rumen protected methionine (RPM). R. Berthiaume^{*1}, P. Dubreuil², M. Stevenson³, B.W. McBride¹, and H. Lapierre⁴, ¹University of Guelph, Guelph, ON, Canada, ²Universite de Montreal, QC, Canada, ³Degussa Huls, Burlington, ON, Canada, ⁴Agriculture & Agri-Food Canada, Lennoxville, QC, Canada.

An experiment was conducted to compare the rates of disappearance of AA from the small intestine and their net appearance in the blood draining only the small intestine (Mesenteric-Drained Viscera (MDV)) and the whole GIT (Portal-Drained Viscera (PDV)) of cows fed a diet supplemented or not with RPM and to determine the effect of RPM on milk protein production. Five lactating dairy cows (118 ± 4 DIM) equipped with duodenal only (n=3) or duodenal and ileal cannulae (n=2) were fed a TMR with 0 or 72 g/d of RPM (Mepron[®] M85, Degussa Huls) in a completely randomised design with two 14-d periods. Two cows with duodenal cannulae were also implanted with chronic catheters in the artery, mesenteric and portal veins. Animals were fed 12 times daily. Chromic oxide was used as a marker to determine digesta flow rates. On day 12 and 13, a total of eight hourly digesta samples were collected

while on day 14 of each experimental periods, six hourly blood samples were simultaneously collected from arterial, mesenteric and portal vessels. Adding RPM to the diet increased ($P=0.05$) the duodenal flux of Met (80.8 vs 37.2 ± 10.8 g/d) leading to a higher ($P=0.01$) digestibility of Met in the whole intestine (75.7 vs 59.4 ± 2.6 %). Eighty two percent of Met from RPM disappeared from the small intestine. Arterial plasma Met concentrations were numerically increased ($P=0.16$; 45 vs 18 ± 4.8 μ M). Milk production (16.9 vs 17.2 ± 0.6 kg/d) and composition were unaffected, except for an elevation ($P=0.03$) in lactose (5.24 vs 4.97 ± 0.03 %). Overall, disappearance of EAA across the small intestine was equivalent (98.8%) to their MDV flux while the PDV:MDV ratio varied from 37.7% for Thr to 76.3% for Phe. PDV:MDV ratio for Met was 66.2%. Feeding RPM did increase absorption of Met but only 20% of the additional Met absorbed reached the portal vein.

Key Words: methionine, rumen protected, dairy cows

1028 IMPEDANCE of subdermal tissue, and its relationship to body condition score of dairy cows along lactation. F. N. Domatob-Fokum^{*} and S. L. Spahr, University of Illinois, Urbana.

Body condition score (BCS), a very useful field tool for estimation of changes in body tissue reserves is time consuming and subjective. The relationship between impedance of subdermal tissue and body condition score was determined as a potential for the development of a low cost, portable, digital impedance sensor for BCS. Five multiparous Holstein dairy cows were implanted with pacemaker electrodes at rib, loin, and rump. Digital impedance of subdermal tissue surrounding each implanted probe was measured with a 16-kHz impedance hand-held meter in alternate days from three weeks before calving to 17 weeks post calving. Cows were scored for body condition every two weeks on a scale of one (emaciated) to five (obese). Retention of implants at the rump site was considerably high compared to the rib and loin. Split-plot analysis of the variance indicated subdermal tissue impedance differed along lactation at all body sites. Subdermal tissue impedance increased during the late dry period and peaked at calving (783 ohms), decreased sharply till week nine (349 ohms) and increased to 414 ohms at week 15. Although slight differences existed, all body sites could be used to predict BCS. An inverse relationship was recorded between BCS and subdermal tissue impedance. At BCS range of 1.84 to 4.30 pre calving, subdermal tissue impedance ranged from 148 to 1850 ohms, and at BCS range of 1.8 to 3.80 post calving, subdermal tissue impedance ranged from 187 to 1408 ohms for all body sites. At BCS of 2.6-0.11, subdermal tissue impedance read 489.2-111. Regression of BCS from subdermal tissue impedance post calving showed R^2 values of 0.28 (rib), 0.46 (loin), and 0.27 (rump). Recording of subdermal tissue impedance removed most of the subjectivity of BCS, but substantial development is needed to reduce time required for data collection, and permanent retention of pacemaker implants on cows before expecting a commercial impedance sensor for scoring cows automatically. Determination of body condition score from subdermal tissue impedance needs further research at higher frequency levels. $\mu\mu\mu\mu\mu\pm$

Key Words: Impedance, subdermal tissue, body condition score

1029 Reproductive efficiency of cows fed monensin. H.B. Green^{*}, J.T. Symanowski, D.G. McClary, J.R. Wagner, J.I.D. Wilkinson, J.S. Davis, and M.R. Himstedt, Elanco Animal Health, Greenfield, IN.

Holstein cows were fed 0, 8, 16 or 24 ppm monensin in total mixed rations (dry matter basis), using a randomized complete block design over nine locations. Treatment began 21d before expected parturition and continued through lactation, the dry period and subsequent calving (L1). At three locations, 249 cows continued on treatment for 200 d of the second lactation (L2). In L1, 560 multiparous and 309 primiparous animals reached the breeding period of 50 to 200 days in milk (DIM). For combined parities, no treatment effects were observed on days to first sign of estrus or overall conception rate in either lactation, nor did monensin affect pregnancy rate or gestation and dry period lengths. Days to first service were not affected in L1, but were increased at 8 ppm and decreased at 24 ppm in L2. First service conception rate was significantly lower for the 24 ppm group compared to control during L1 but not during L2. As a result, days open during L1 and calving interval were longer for the 24 ppm group than control. Female calves from monensin treated cows weighed more at birth than controls, but

ppm and decreased at 24 ppm in L2. First service conception rate was significantly lower for the 24 ppm group compared to control during L1 but not during L2. As a result, days open during L1 and calving interval were longer for the 24 ppm group than control. Female calves from monensin treated cows weighed more at birth than controls, but birth weights of male calves were not different. There was no difference in calving difficulty between treatment groups. Average daily gain of female calves to 28 d of age was not different between groups. Monensin did not affect multiple birth rate or calf gender ratio.

Parameter	Lactation	Monensin			
		0 ppm	8 ppm	16 ppm	24 ppm
Number of cows (9 sites) 50-200					
DIM	L1	218	211	219	221
Inseminated	L1	213	209	213	216
Conceived	L1	181	177	170	179
Calved	L1	160	155	149	164
(3 sites) 50-200					
DIM	L2	60	61	55	60
Inseminated	L2	58	56	54	59
Conceived	L2	48	47	44	46
Days to 1st service					
	L1	84.1	84.7	86.9	83.6
	L2 ^a	89.7	97.5	89.0	83.1
1st service conception rate	L1 [#]	0.499	0.427	0.448	0.378*
	L2	0.439	0.560	0.366	0.424
Overall conception rate	L1	0.431	0.415	0.404	0.379
	L2	0.435	0.458	0.352	0.326
Days open					
	L1	99.8	104.6	100.4	107.7*
	L2	102.0	101.4	111.3	105.8
Calving interval, days [#]					
		380.8	383.6	381.8	389.6*
Female calf wt, kg [#]					
		40.8	43.0*	42.8*	43.5*
Male calf wt, kg					
		45.6	46.9	46.2	45.9

1031 Carcass composition and meat quality from New Zealand, California, Chinchilla and Rex rabbits. A. Ortiz and M. S. Rubio*, *Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autonoma de Mexico, Mexico.*

The objective of this study was to determine the differences on dressing percentage, carcass composition and meat quality from four rabbit breeds. Forty rabbits, 10 New Zealand (NZ), 10 California (CA), 10 Chinchilla (CH) and 10 Rex (RX), from both sexes were used. Animals were fed commercial diets until reaching an average weight of 2 kg at the time of slaughter. Dissection was carried out on the left half of the carcass to obtain the main tissues percentages (bone, muscle, internal, intermuscular and subcutaneous fat and other tissues). Muscles from the right legs were used to determine chemical composition of the meat. The loin muscles from the right half carcasses were used to run Warner-Bratzler shear force test. Left side legs were cooked and a consumer sensory panel using 85 people was carried out on different Mexican regional markets. Results were analyzed using a descriptive analysis and breed and sex were the independent variables. Dressing percentage was no different among breeds. NZ carcasses had the higher loss for overnight cooling. Dissection showed that RX had the lowest percentage of bone (16.44±2.45) and the highest percentage of internal fat (2.53±0.56) compared to NZ that had the highest (19.64±1.18) and the lowest (17.04±0.95), respectively. No differences were found with respect to muscle percentage among breeds. Shear force results were similar for the four types of rabbit meat. Chemical composition of the loin muscles showed no differences among breeds. Consumer sensory panel showed that meat from CH animals had the best aroma (5.14±1.19) compared to that from NZ (4.75±1.00). Meat from RX animals resulted in the most tender compared to CA meat (5.38±1.00 and 4.85±1.30, respectively). These results suggest that meaty rabbits (CA & NZ) are

*P<0.1 vs control, ^aP<0.1 treatment χ^2 test, [#]P<0.1 linear trend

Key Words: Monensin, Reproduction

1030 Management tools for assessing passive immunity transfer in dairy calves. K.M. Kouri*, D.D. LaCoss, D.E. Watkin, J.W. Barlow, and J.R. Knapp, *University of Vermont, Burlington, VT.*

Twenty-three Holstein and Jersey calves were used to evaluate effects of colostrum management and to evaluate three methods of determining adequate passive immunity transfer. Calves were fed 2L of colostrum at birth and another 2L at 12h post-partum (pp). Blood was sampled before colostrum feeding and at 6 and 24h pp and serum collected. Serum was immediately tested for total serum protein using a refractometer and for serum IgG using the Midlands Bioproducts Quick Test. Serum and colostrum were stored and assayed later using a radioimmunoassay (RID) kit from VMRD, Inc. Differences in serum IgG as determined by refractometer and RID were tested using the SAS-GLM procedure. The validity of the Quick Test was compared using the serum IgG values determined by RID. The refractometer results differed from RID results 7.3% of the time, while the Quick Test differed from the RID 9.7% of the time. Regression equations were developed between total serum protein measured by the refractometer and IgG levels measured by RID at both 6 and 24h pp. The equations agree with previously published equations for serum IgG at 24h pp. As expected, significant differences were found between pre-feeding and post feeding IgG levels (p<.01). Differences (p<.01) were also observed between IgG levels at 6 and 24h pp, with levels increasing over time. This would suggest that the second feeding of 2L colostrum at 12h pp significantly increased the probability that passive transfer occurred by 24h pp. Adequate passive transfer (serum IgG \geq 10 mg/dl) was achieved in 20 of the 23 calves. In summary, the Quick Test and refractometer are both valuable tools for assessing a calf's IgG status in the first 24 hours after birth. Beyond the use of these tools, passive transfer in neonatal dairy calves can be most easily achieved with a well planned and implemented colostrum feeding protocol based on the use of high quality colostrum.

Key Words: Colostrum, Immunoglobulin G, Calf Nutrition

RABBIT SPECIES

leaner and have less aroma and tenderness than the pelt (CH & RX) rabbits.

Key Words: Rabbits, Carcass composition, Meat, Sensory

1032 Effect of supplementation with animal plasma and antibiotics of starter diets in rabbits. I. Gutierrez¹, P. Cachaldora², R. Carabaño¹, P. Medel^{*1}, and C. de Blas¹, ¹*Departamento de Produccion Animal, E.T.S.I. Agramonos*, ²*COREN, S.C.L.*

This study evaluated the inclusion of animal plasma (Appetein[®]) and antibiotics (a mixture of 100 ppm Bacitracine and 60 ppm of Apramidine) in diets for early-weaned rabbits (25 d of age). Two feeding trials using 280 individually- and 420 collectively-caged (groups of four) animals, and a digestibility trial using 66 animals in metabolism cages, were conducted. Six diets were formulated using a factorial arrangement with three levels of animal plasma (0, 2, and 4%) and supplementing with or without antibiotics. Inclusion of animal plasma was made on an iso-nutritive basis, by substituting an increasing amount of soybean meal with a mixture of animal plasma and sugar beet pulp. The experimental diets were fed in the first two-weeks after weaning. After that, all the animals received a common commercial fattening feed. The type of diet did not affect DM or CP digestibility, which averaged 62.3 and 77.7%, respectively. Both animal plasma and antibiotic inclusion improved growth performance, but the response was more apparent at earlier ages and when environmental conditions were poorer. In these conditions, inclusion of a 4% of animal plasma increased feed intake (67.4 vs 72.8 g/d, P < .05) and weight gain (35.8 vs 38.4 g/d, P < .05), but feed efficiency was not affected. However, no significant effects of dietary treatments were found for the whole fattening period. Antibiotic supplementation had a similar effect as animal plasma on growth traits in young animals, and furthermore was effective (but not animal

plasma addition) in reducing mortality caused by epizootic rabbit enteritis. From this study it can be concluded that animal plasma is a highly palatable and digestible source of protein for early-weaned rabbits. Based on our results, the positive response to animal plasma may depend on the age, the environmental conditions and the health status of the animals.

Key Words: Animal Plasma, Antibiotics, Early Weaned Rabbits

1033 Bovine follicular fluids modulate the release of transaminases, acrosome reaction and motility of rabbit sperm. M.M. Zeitoun*, Faculty of Agriculture, Alexandria University, Egypt.

This study investigates the effect of supplementing bovine follicular fluids (FF) to rabbit sperm motility, acrosome reaction and transaminases activities. Ovarian FF were collected from 46 pairs of bovine ovaries. Normal follicles were classified, according to their diameters, into small (SFF, ≤ 4 mm), medium (MFF, $>4-8$ mm), large (LFF, > 8 mm) and cystic (CSTFF, >20 mm). Rabbit semen was collected and diluted with EBSS-P medium and incubated in a CO₂ incubator at 37 °C. Two levels (20 and 40%) of FF were tested. Sperm motility index (SMI), percent acrosome reaction (%AR) and the activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) in the extracellular

media were determined. Sperm motility was decreased by FF addition ($P<0.01$). As the diameter of follicle increased the reduction in motility decreased ($P<0.01$). On the other hand, the cystic FF caused the highest reduction in sperm motility. As time of incubation progressed a sharp decline was observed ($P<0.01$) in sperm motility. Addition of FF increased ($P<0.01$) the reacted acrosome (16.7, 16.3, 17.1, 20.1 and 13.1% for , large , medium , small, cystic FF and control, respectively). A linear increase ($P<0.01$) of acrosome reaction was obtained as incubation time advanced (13.3, 15.3, 17.2 and 22.1 % at 0, 1, 2 and 4 hr, respectively). The release of AST and ALT significantly ($P<0.01$) increased by FF treatment and time progression. As the FF level increased the activity of ALT increased ($P<0.01$). In all cases, the addition of FF increased the release of ALT greater than in the control, however in the case of AST, large FF did not change its release compared to the control. Cystic FF always increased both enzyme activities. There was a positive correlation coefficient between ALT activity and percent of reacted acrosome. On the other hand, a significant negative correlation coefficient was found between sperm motility and acrosome reaction. In summary, bovine FF modulates rabbit sperm characteristics.

Key Words: Bovine Follicular Fluids, Rabbit Sperm, AST, ALT

RUMINANT NUTRITION

1034 Ionophores for dairy cattle: current status and future outlook. R. K. McGuffey*, L. F. Richardson, and J. I. D. Wilkinson, Elanco Animal Health, Greenfield, IN.

Ionophores are used commercially throughout the world in the beef and poultry industries. Production efficiency of cattle is increased through alteration of rumen fermentation and control of protozoa that cause coccidiosis. Ionophores act by interrupting transmembrane movement and intracellular equilibrium of ions in certain classes of bacteria and protozoa that inhabit the gastrointestinal tract. The actions of ionophores provide a competitive advantage for certain microbes at the expense of others. In general, metabolism of the selected microorganisms favors the host animal. Energy metabolism is enhanced through increased production of propionate among ruminal fatty acids with a concomitant reduction in methane. Ruminal degradation of peptides and amino acids is reduced thereby increasing the flow of protein of dietary origin to the small intestine. Total flow of protein to the lower tract is often increased with ionophore feeding. Risk of digestive disorders such as bloat and acidosis that result from abnormal rumen fermentation is reduced as are certain conditions caused by toxic products of fermentation, e.g., 3-methyl indole. Dry matter and nitrogen digestibilities are increased with ionophores thereby providing environmental benefits. Monensin and lasalocid have been the most studied in research demonstrating benefits to the dairy cow. Ionophores enhance the glucose status of dairy cows through increased production of propionate. Many of the demonstrated benefits of ionophores are associated with enhancement of the energy status of the cow in the transition period and during early lactation. The benefits include less mobilization of body fat as evidenced by reduced blood nonesterified fatty acids and ketones and increased glucose. Animal manifestations include lower incidence of ketosis and displaced abomasum, reduced loss of body condition, increased milk production and improved milk production efficiency.

Key Words: Ionophore, Dairy Cows, Lactation

1035 Milk production of Holstein x Sahiwal cows receiving monensin and a sustained release formulation of methionyl bovine somatotropin. T. P. Pelaez¹, I. A. Duque¹, D. Zambrano¹, E. Plaza², V. A. Reyes², N. S. Defaz², C. Gonzalez³, E. Bernal³, and R. K. McGuffey³, ¹Universidad Estatal de Quevedo, Quevedo, Ecuador, ²Rey Sahiwal, Grupo Wong, Guayaquil, Ecuador, ³Elanco Animal Health, Bogota, Colombia.

Monensin (M) in a dairy concentrate (0 or 100 g/ton) and bovine somatotropin (bST) (500 mg/14 days) were administered in a 2 X 2 arrangement of treatments to 112 Holstein X Sahiwal lactating cows for 112 days to determine effects on milk yield and bodyweight. Cows averaged 80.3 days in milk at the beginning of treatments. Cows grazed on pastures of African stargrass (*Cynodon nlemfuensis*) and guinea grass (*Panicum*

maximum). They were fed the medicated concentrate at milking followed by an offering of waste bananas (*Musa sp*) after milking during the experiment. Results are shown in the table. Milk production was increased by M and bST. Weight gain favored cows receiving M and bST.

Item	Control	Mon(M)	bST	M+bST
Conc,kg/d	2.23	2.15	2.44	2.33
Milk,l/d				
Pretrt (P)	13.7	12.8	13.3	13.8
Trt (T)	10.1	10.2	11.2	12.0
T/P (%)	73.5	79.7	83.9	86.7
Bwt, kg				
Start T	402	377	400	414
End T	411	392	419	435
Gain	9	15	19	21

Key Words: Monensin, Bovine Somatotropin, Pasture

1036 Effects of lasalocid on the forage to concentrate ratio fed to steers maintained at pre-determined daily average ruminal pH. D.L. Prentice*, D.M. Schaefer, and G.R. Oetzel, University of Wisconsin, Madison.

Two experiments were conducted to evaluate the effects of lasalocid (325 mg·hd⁻¹·d⁻¹) on the forage to concentrate ratio fed to steers at a specific, pre-determined daily average ruminal pH. Eight ruminally cannulated Holstein steers were used in a two-by-two crossover trial. In both experiments corn silage was the only source of forage. Indwelling ruminal pH electrodes were used to continuously monitor ruminal pH and diets were adjusted daily for each steer to achieve the target ruminal pH. The daily average ruminal pH target was 6.0 in experiment one and 5.5 (the upper limit of subacute ruminal acidosis) in experiment two. In experiment two finely ground corn was used in a 50:50 mix with the whole kernel corn of experiment one to facilitate a lower pH. In both experiments lasalocid had no significant effect on the percent forage fed to maintain the pre-determined daily average ruminal pH. Lasalocid had no significant effect on DMI, the area of the ruminal pH curve under 5.5, ruminal pH variance, ruminal pH nadir, ruminal pH peak or overall ruminal pH range. The effects of lasalocid on total VFA concentration and VFA profiles were inconsistent in both experiments. The average ruminal pH in experiment one was 5.99 for lasalocid-fed animals and 5.98 for controls. It was possible to feed to an average daily ruminal pH of 6.0 by altering the forage and concentrate ratios on an individual basis.

The average ruminal pH in experiment two was not significantly different between treatments and was 5.82 for lasalocid and 5.74 for controls. The target pH of 5.5 in experiment two could not be achieved by altering forage to concentrate ratio. Animals in experiment two did spend more time with ruminal pH ≤ 5.5 compared to experiment one. Dry matter intake decreased as percent concentrate increased in experiment two. Decreasing DMI may have allowed the steers to maintain ruminal pH above the range of subacute acidosis and may have prevented them from reaching the lower pH target.

Key Words: Lasalocid, Ruminal pH, Subacute acidosis

1037 Monensin has anti-foaming properties. P. J. Moate^{*1}, T. Clarke², L. Davis², E. Bastiensen, and R. Laby², ¹University of Pennsylvania, ²Agriculture Victoria Ellinbank.

In recent years, monensin has been used by the Australian Dairy industry as the active ingredient in the commercially successful anti-bloat capsule (ABC) marketed by Elanco Animal Health. Although the ABC has been successful in reducing the incidence of bloat in grazing cattle, the mechanism of action of monensin against bloat is still unclear. Bloat in cattle usually occurs due to the formation in the rumen of persistent foam that prevents the eructation of fermentation gases. The other successful anti-bloat agents (detergents, oils fats and tannins) all influence the foaming properties of plant proteins within the rumen. The objective of this research was to measure the effects of monensin and hexaglycerol distearate (HGDS, the other major constituent of the ABC) and of core material from an ABC on the strength and persistence of protein foams. The foaming solution consisted of a phosphate buffer that contained 0.1% protein (purified from the leaves of red clover). Monensin, HGDS and ABC core material were added to the protein solution at final concentrations of 5 ppm. Foams were generated in a Mangan apparatus. Monensin and HGDS reduced the strength of protein foams. Core material from the ABC strongly reduced strength and persistence, indicating monensin with HGDS has a synergistic anti-foaming effect. This is the first time monensin has been reported to have direct anti-foaming properties. The mechanism of action of monensin in reducing bloat and stimulating voluntary intake in both grazing and feedlot cattle, may be in part due to its anti-foaming properties.

Solution	*Strength (g/cm ²)	*Persistence (minutes)
Control	2.44a (0.21)	11.2a (2.0)
Monensin	2.09 (0.05)	9.2ab (1.2)
HGDS	2.07b (0.15)	9.5ab (1.0)
ABC Core	1.77c (0.22)	7.8b (2.0)

*Values shown are means (\pm S.D.). Means in the same column with different letters differ significantly ($P < 0.05$).

Key Words: Cattle, Monensin, Anti-foaming

1038 Effects of monensin and dietary phosphorus concentration on mineral metabolism of grazing steers. S. M. Williamson*, E. B. Kegley, T. J. Wistuba, W. K. Coblenz, C. P. West, K. P. Coffey, and D. G. Galloway, University of Arkansas, Fayetteville.

Twenty Angus-crossbred steers (initial BW 209 \pm 6.3 kg) were used to evaluate the effects of monensin (0 or 175 mg/d) on performance and mineral metabolism of steers grazing continually stocked warm-season grass pastures that differed in spatial variation of soil test phosphorus (< 337 kg/ha and > 337 kg/ha). This resulted in a 2 \times 2 factorial arrangement of treatments. Steers were stratified by weight and randomly assigned to the four treatments. A soybean hull based supplement (0.88 kg) was individually fed once daily throughout the experiment to administer monensin. After 28-d, steers were divided into two collection groups for total fecal and urine collection. This consisted of a 5-d metabolism crate adaptation and a 5-d collection period. Forage for the collection period was clipped daily from pastures of the same soil test P concentrations as the grazed pastures. Concentrations of P in forage samples taken throughout the grazing period averaged 0.35 and 0.30% for high and low soil test P pastures. Phosphorus concentrations in the clipped samples that were fed during the collection periods were 0.40 and 0.27% for high and low soil test P pastures, respectively. Treatment did not affect growth performance of calves during the grazing phase or DM digestibility during the metabolism phase. Supplementation with monensin did not affect ($P > 0.10$) percentage apparent absorption or

percentage retention of P. Steers fed forage from the high soil test P plot had increased P intake ($P < 0.001$), and fecal P excretion ($P < 0.05$). Phosphorus absorbed and retained (g/d) were increased ($P < .01$) in calves fed forage from the high soil test P plot. In addition, the percentage apparent absorption (39 vs 22%, $P < 0.001$) and percentage retention (26 vs 16%, $P < 0.02$) were increased in the calves fed forage from the high soil test P plot. Supplementing monensin to grazing calves did not alter P balance; however, P balance of calves was affected by soil test P concentration.

Key Words: Phosphorus, Cattle, Monensin

1039 Effect of salinomycin or monensin on performance and feeding behavior of cattle fed wheat- or barley-based diets. D. J. Gibb^{*1}, S.M.S. Moustafa¹, R. D. Wiedmeier², and T. A. McAllister¹, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²Utah State University, Logan.

Feeding behavior and growth performance of cattle fed diets containing monensin or salinomycin were assessed in two trials. In trial 1, 36 Hereford \times Angus steers (267.7 \pm 4.3 kg) were individually fed ($n = 12$) wheat-based transition and finishing diets containing no ionophore (control, C), 26 mg monensin (M) or 13 mg salinomycin (S) per kg dietary DM. Cattle fed M consumed less than those fed C or S, but their intake was more stable during transition. Overall, steers fed M had lower DM intake (8.0 vs 9.2 and 9.2 kg d⁻¹) and rate of gain (1.21 vs 1.62 and 1.56 kg d⁻¹) than those fed C or S. Cattle fed S required fewer ($P < .05$) days to finish (to 5 mm backfat) than did those fed C or M (93.3 vs 105.8 and 105.8). Monensin-fed steers had lower ($P < .05$) slaughter and carcass weights relative to controls (414.3 vs 480.5 kg, and 231.2 vs 245.8 kg, respectively). In trial 2, M (25 ppm) or S (13 ppm) were included in barley-based diets for 72 yearling steers in four pens equipped with radio frequency identification systems. Individual bunk attendance patterns were monitored during transition to a finishing diet, and while limit-feeding the finishing diet twice daily (LF2/d), limit-feeding once daily (LF1/d), and feeding to ad libitum intake once daily (AL1/d). Ionophore type did not affect ($P > .10$) DM intake, rate of gain or efficiency of feed conversion. Bunk visits were more frequent ($P < .05$) with M than with S during transition and limit-feeding. With M, total daily attendance (TDA) at the bunk during LF1/d and AL1/d, was higher ($P < .05$) than with S, and variability in TDA was lower ($P < .05$) during LF1/d. In the present study, there was no performance advantage in providing S or M in wheat-based finishing diets. Monensin moderated intake of the barley-based diets better than S, but this effect may have been strong enough to suppress intake and even reduce gain on the wheat-based diet.

Key Words: Ionophores, Feeding behavior, Feedlot cattle

1040 Effect of sugars and malate on ruminal microorganisms. S. A. Martin*, H. M. Sullivan, and J. D. Evans, University of Georgia, Athens.

The objective of this study was to examine the effects of a commercial feed supplement that contains sugars and malate on lactate fermentation by *Selenomonas ruminantium* grown in batch culture. Experiments were also conducted to examine the effects of this feed supplement on the mixed ruminal microorganism fermentation of ground corn and soluble starch in the presence and absence of 5 ppm monensin. When *S. ruminantium* strains HD4 and H18 were incubated with only DL-lactate, little DL-lactate was utilized by either strain after 24 h. In the presence of 1 g/L sugars plus malate, both strains utilized most of the carbohydrate associated with the feed supplement between 6 and 8 h and lactate was the main end product that was produced. In ground corn fermentations by mixed ruminal microorganisms, 2.25 and 3.25 g/L sugars plus malate increased concentrations of acetate, propionate, and total VFA, while 3.25 g/L increased lactate and decreased final pH and butyrate. Fermentation of soluble starch in the presence of both concentrations of sugars plus malate increased concentrations of acetate, propionate, and total VFA and decreased the acetate:propionate ratio. In the presence of 5 ppm monensin, sugars plus malate treatment increased concentrations of propionate and total VFA in ground corn and soluble starch fermentations. Collectively, these results suggest that sugars plus malate stimulate the ruminal fermentation.

Key Words: sugars plus malate, rumen, microorganisms

1041 Effect of replacing dietary starch with sucrose on milk production in lactating dairy cows. G. A. Broderick^{*1}, N. D. Luchini², W. J. Smith¹, S. Reynal³, G. A. Varga⁴, and V. A. Ishler⁴, ¹*U.S. Dairy Forage Research Center, Madison, WI*, ²*Conti-Group Co., Chicago*, ³*University of Wisconsin, Madison*, ⁴*Pennsylvania State University, University Park*.

Two sets of 24 Holstein cows (41 ± 5 kg/d of milk) were blocked by DIM and randomly assigned in two flights to four groups of 6 cows and fed TMR containing (DM basis): 40% alfalfa silage, 20% corn silage, 20.5% rolled high moisture shelled corn, 9% soybean meal, 2% fat, 1% vitamin-mineral supplement, 7.5% supplemental non-structural carbohydrate (NSC), 16.7% CP, and 29% NDF. The NSC fed in the four diets was: 7.5% corn starch, 0% sucrose; 5.0% starch, 2.5% sucrose; 2.5% starch, 5.0% sucrose; or 0% starch, 7.5% sucrose. The diet with 7.5% starch was fed for a 2-wk covariate period then cows were fed their assigned diets for 8-wk. Milk yield was measured at each milking; DMI was determined daily. Yield of milk components was determined from milk samples taken at both daily milkings one day during the covariate and every 2-wk during the experimental period. The statistical model included flight (n = 2), block (n = 12), and covariate yield of each milk component; LS means are reported below. There were linear increases (P ≤ 0.05) in DMI and milk fat content and yield as sucrose increasingly replaced corn starch in the diet; there was a linear decline (P = 0.02) in milk/DMI with increasing sucrose. No other yield trait was affected significantly.

Item	% Sugar				SEM	Linear ¹	Quad-ratic ¹
	0	2.5	5.0	7.5			
	% Starch						
	7.5	5.0	2.5	0			
DMI, kg/d	24.5	25.6	26.0	26.0	0.4	0.01	0.17
Milk, kg/d	38.9	40.4	40.0	39.4	0.7	0.74	0.15
Milk/DMI	1.60	1.58	1.54	1.52	0.03	0.02	0.96
FCM, kg/d	40.5	42.2	43.9	43.2	1.3	0.11	0.38
Fat, %	3.81	3.82	4.07	4.16	0.11	0.01	0.73
Fat, kg/d	1.47	1.53	1.65	1.62	0.06	0.05	0.47
Protein, %	3.24	3.22	3.27	3.30	0.04	0.23	0.54
Protein, kg/d	1.24	1.28	1.29	1.28	0.03	0.35	0.36
Lactose, %	4.75	4.74	4.77	4.74	0.04	0.95	0.90
Lactose, kg/d	1.84	1.91	1.90	1.85	0.06	0.95	0.37
SNF, %	8.76	8.76	8.87	8.82	0.06	0.34	0.68
SNF, kg/d	3.38	3.51	3.51	3.44	0.10	0.69	0.32

¹Probability of linear and quadratic effects of dietary sucrose concentration.

Key Words: Sugar, Starch, Milk yield

1042 Performance of lactating dairy cows fed citrus pulp or corn products as sources of neutral detergent-soluble carbohydrates. E. Leiva¹, M. B. Hall^{*1}, and H. H. Van Horn¹, ¹*Dept. of Dairy & Poultry Sciences, University of Florida, Gainesville*.

Reversal experiments were used to examine the effects of changing the dietary profile of neutral detergent-soluble carbohydrates (NDSC) on performance of lactating dairy cows and on ruminal fermentation. Corn silage and alfalfa hay-based diets were formulated to contain 40% calculated NDSC supplied primarily by dried citrus pulp as a source of sugars and neutral detergent-soluble fiber (NDSF), or corn products (hominin or corn meal) as sources of starch. In study 1, 11 multiparous Holstein cows including 3 ruminally-cannulated animals were individually fed diets containing 23.6% citrus pulp (diet CIT) or 25.3% corn hominin (diet HOM) on a dry matter (DM) basis. In study 2, 184 animals fed as two groups received diets containing 20.5% citrus pulp (diet CIT) or 19.5% corn meal (diet CM) on a DM basis. Diets were formulated to contain similar amounts of N and NDF. Diet CIT provided more NDSF and diets HOM and CM supplied more starch. Significance was declared at P < 0.10, tendency at P < 0.15. In study 1, cows fed diet HOM had a greater milk protein percentage (2.83 vs 2.71%), and tended to yield more milk protein. Although ruminal hydrogen ion concentrations ([H⁺]) did not differ between diets, the change in [H⁺] with time was linear for H, and quadratic for CIT. Ruminal concentrations of VFA did not differ between diets. In study 2, cows fed CM had greater yields of milk, 3.5% fat- and protein-corrected milk (3.5%FPCM), fat and protein. Cows fed CIT produced greater concentrations of milk fat (3.45 vs 3.27%), and milk urea nitrogen (9.57 vs 8.81 mg/dl). Modifying the proportions of NDSF and starch in the diet can alter milk production, milk composition, and the pattern of ruminal fermentation in dairy cows.

Diets:	Study 1		Study 2	
	CIT	HOM	CIT	CM
NDSF% of diet DM	13.8	8.2	15.0	12.0
Starch% of diet DM	15.0	26.4	12.9	19.0
DM intake, kg/d	20.9	21.4	18.9	19.5
Milk, kg/d	31.3	32.8	27.9	31.8
Milk fat, kg/d	1.11	1.12	0.97	1.02
Milk protein, kg/d	0.85	0.93	0.88	0.96

Key Words: NSC, Starch, Soluble Fiber

1043 Effects of conservation method of corn grain and dietary starch content on DMI and productivity of lactating dairy cows. M. Oba^{*} and M. S. Allen, *Michigan State University, East Lansing*.

Effects of conservation method of corn grain and dietary starch content on DMI and productivity of lactating dairy cows were evaluated. Eight ruminally and duodenally cannulated Holstein cows (55±15.9 DIM; mean±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Mean particle size and DM content of corn grain were 1.86 mm and 63.2%, and 0.89 mm and 89.7%, for HM and DG, respectively. True starch digestibility in the rumen was 71.1 and 46.9% for HM and DG, respectively in high starch diets, and 58.5 and 45.9% for HM and DG, respectively in low starch diets. The HM treatment decreased DMI compared to DG in high starch diets (20.8 vs. 22.5 kg/d), while there was no difference in low starch diets (19.7 vs. 19.6 kg/d). This reduction in DMI is attributed to smaller meal size for HM compared to DG in high starch diets (1.9 vs. 2.3 kg of DM for high starch diets; 2.1 vs. 2.0 kg of DM for low starch diets). Faster starch fermentation for HM in high starch diets might result in satiety sooner. Milk yield was greater for cows fed high starch diets compared to cows fed low starch diets (38.6 vs. 33.9 kg/d) regardless of corn grain treatment. HM decreased 3.5% FCM compared to DG in high starch diets (35.7 vs. 38.7 kg/d), while there was no difference in low starch diets (35.7 vs. 35.4 kg/d). This is because of lower milk fat content for cows fed HM in high starch diets (3.05 vs. 3.59% for high starch diets; 3.95 vs. 3.73% for low starch diets). Milk protein content was lower for HM in high starch diets (2.98 vs. 3.02%) but higher for HM compared to DG in low starch diets (2.94 vs. 2.87%). Reducing ruminal starch fermentation by substituting DG for HM can increase productivity of lactating cows fed high starch diets.

Key Words: Dry matter intake, Corn grain, Ruminal starch digestion

1044 Effects of conservation method of corn grain and dietary starch content on starch digestibility and efficiency of microbial N production in lactating dairy cows. M. Oba^{*} and M. S. Allen, *Michigan State University, East Lansing*.

Effects of conservation method of corn grain and dietary starch content on starch digestibility and efficiency of microbial N production were evaluated. Eight ruminally and duodenally cannulated Holstein cows (55±15.9 DIM; mean±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Mean particle size and DM content of corn grain were 1.86 mm and 63.2%, and 0.89 mm and 89.7%, for HM and DG, respectively. True starch digestibility in the rumen was higher for HM compared to DG, and the difference was greater for high starch diets (71.1 vs. 46.9%) compared to low starch diets (58.5 vs. 45.9%). This interaction is attributed to a greater increase in digestion rate of starch for HM compared to DG in high starch diets (28.2 vs. 14.6 %/h) compared to low starch diets (16.8 vs. 12.2 %/h). This suggests that ruminal starch digestion is limited by enzyme activities as well as substrate availability; ruminal contents of cows fed low starch diets may have insufficient amylolytic activity for maximal starch digestion when readily fermentable starch is available. Starch digestibility in the total tract was not affected by corn grain treatment because of compensatory digestion post-ruminally. The HM treatment decreased microbial N production efficiency compared to DG (39.7 vs. 48.4 g/kg of truly ruminally fermented OM). However, post-ruminal digestibility for non-ammonia nitrogen was greater for HM compared to

DG, and the increase was greater for high starch diets (74.3 vs. 68.7%) compared to low starch diets (71.2 vs. 70.6%). This might be attributed to greater microbial N excretion as feces due to enhanced starch digestion in the large intestine for cows fed DG compared to cows fed HM or to more resistant protein for DG compared to HM. Effects of corn grain conservation method on nutrient digestion are greatly altered by starch content of diets.

Key Words: Corn grain, Ruminal starch digestion, Microbial N production

1045 Effects of Speciality Corn Hybrids on Lactation Performance of Dairy Cows. V. Akay* and J. A. Jackson, *University of Kentucky, Lexington.*

Six multiparous (81 ± 9 DIM) and six primiparous (79 ± 4 DIM) lactating dairy cows were fed three diets in a replicated 3 x 6 Latin rectangle design with 28 d periods. The objective of this study was to determine the effects of speciality corn hybrids as silage and grain sources on milk yield and composition. Diets were: 1) control (normal yellow dent corn), 2) nutridense corn (high oil and protein), and 3) waxy corn (high amylopectin) diets. Diets contained 11% alfalfa silage, 33% corn silage (from the respective corn treatment), 28% cracked corn grain (from the respective corn treatment), and 28% other ingredients (DM basis). Data were analyzed using General Linear Procedure of SAS; means were separated by least significant difference. Except for body weight change (BWC), the parity x treatment interaction term in the model was not significant, and therefore data were analyzed without interaction term in the model. Multiparous cows that were fed normal corn diet gained body weight while those fed nutridense or waxy corn diets lost body weight (5.99, -9.24 and -1.29 kg, respectively). However, BWC was similar between diets for primiparous cows. Pooled data from multiparous and primiparous cows indicated that BWC, milk fat percentage and milk protein yield were similar between diets. The 3.5% fat-corrected milk (FCM) (34.2, 35.5 and 36.4 kg/d, respectively) and milk fat yield (1.23, 1.28 and 1.31 kg/d, respectively) were higher for cows fed the waxy corn diet than those fed the normal corn diet. Milk protein percentage (3.21, 3.15 and 3.22%, respectively) was higher for cows fed waxy corn diet than those fed the nutridense corn diet. Dry matter intake (DMI) (23.9, 23.8 and 24.4 kg/d, respectively) and milk yield (33.0, 34.2 and 34.9 kg/d, respectively) tended (NS) to be higher for cows fed waxy corn diet than for those fed the normal corn diet. Milk yield/DMI (1.38, 1.43 and 1.43, respectively) tended (NS) to be higher while FCM/DMI (1.43, 1.49 and 1.49, respectively) was higher for cows fed nutridense and waxy corn diets than those fed normal corn diet. Nutridense corn hybrid as grain and silage did not improve lactation performance of dairy cows; however, waxy corn hybrid as grain and silage improved lactation performance of dairy cows when compared with normal yellow dent corn hybrid.

Key Words: Speciality corn hybrids, Lactation, Dairy cows

1046 The Lactational Response to Diets Containing Conventional or High Oil Corn Fed at Two Dietary Energy Concentrations. L. A. Whitlock*, D. J. Schingoethe, A. R. Hippen, and K. M. Kasperon, *South Dakota State University, Brookings.*

Milk production and composition were evaluated using 12 multiparous Holstein cows which were randomly assigned in a replicated 4 x 4 Latin square design with 4 wk periods. The four treatments consisted of a control diet (C) using conventional corn with a 50:50 ratio of forage to concentrate, a diet with high oil corn replacing the conventional corn (CHO), a low energy diet (L) using conventional corn with a 60:40 ratio of forage to concentrate, and a low energy diet with high oil corn replacing the conventional corn (LHO). Milk production (34.8, 35.4, 33.6, and 33.3 kg/d for cows fed C, CHO, L, and LHO diets, respectively) was lower ($P < 0.05$) for cows fed lower energy diets but was similar ($P > 0.05$) for conventional and high oil corn diets. Milk fat (3.88, 3.88, 4.00, and 4.17%), and protein (3.22, 3.26, 3.18, and 3.32%) contents were similar ($P > 0.05$) for all diets. Contents of conjugated linoleic acid (CLA) and transvaccenic acid (TVA) in milk were increased 35 to 45% ($P < 0.05$) when fed CHO instead of C, but increased only slightly ($P > 0.05$) when fed LHO instead of L. Milk production was not increased when fed high oil corn in place of conventional corn in either normal or low energy diets.

Key Words: High Oil Corn, Milk, Conjugated Linoleic Acid

1047 Utilization of barley in diets of lactating cows. R. L. Kincaid*¹, J. H. Harrison², W. Sanchez³, and C. W. Hunt⁴, ¹*Washington State University, Dept. of Animal Sciences, Pullman,* ²*Washington State University, Puyallup,* ³*Church and Dwight, Inc., Princeton, NJ,* ⁴*University of Idaho, Moscow.*

The chemical composition of barley differs significantly among agronomic varieties. Baroness, Idagold, and Harrington varieties typically have high starch and low fiber contents, and Steptoe typically has lower starch and higher fiber content. Three experiments were conducted with lactating cows to determine the relative nutritive value of the barley varieties compared to corn. The first experiment evaluated Baroness, Idagold, and Steptoe barley. Forty cows in mid-lactation were blocked by parity and milk yield and composition recorded. Milk yields (kg of 3.5 FCM) were: Baroness, 24.8^a corn, 23.8^{a,b}; Idagold, 23.6^{a,b}; and Steptoe, 22.7^b. DMI of cows were lowest for Steptoe (20.5 kg) and greatest for Baroness (24 kg). A second experiment evaluated milk yield, diet digestibility, and intestinal flow of N in cows fitted with ruminal and duodenal cannulae. Cows fed Baroness had the lowest ($P < .05$) total tract digestibility of starch. Flows of total N, microbial N, feed N, and ammonia N into the duodenum did not differ among treatments. However, there was significantly greater ($P < .05$) flow of Met and Lys into the duodenum of cows fed Idagold and reduced flow in cows fed either Baroness or corn. Milk yields were greatest for cows fed Idagold and Harrington barley, and least for cows fed Baroness or Steptoe barley or corn. A third experiment used 48 lactating cows in a 4 x 4 Latin square design to compare corn and barley (Baroness) with two levels of dietary Ca (.6 and 1.2%). The Latin square had 4 periods of 28 d each. Milk yield did not differ among treatments, but cows fed Baroness had higher ($P < .05$) percent milk fat and yield of fat. In conclusion, barley varieties differ significantly in their feeding value for lactating cows. Varieties of barley with lower fiber contents can replace corn in rations of cows in mid-lactation without affecting milk yield.

Key Words: Barley, Corn, Cows

1048 Growth response of post-weaned dairy heifers to level of rumen undegradable protein in the total ration dry matter. B.A. Hopkins* and L.W. Whitlow, *North Carolina State University, Raleigh.*

Thirty-six post-weaned Holstein heifers, approximately 8 weeks of age, were assigned randomly to treatments for 112 days in a study designed to determine the optimum level of dietary rumen undegradable protein (RUP) in a 15% crude protein (CP) diet. Heifers received a total mixed ration that contained 15% CP and was formulated to contain one of the following levels of RUP as a percentage of the CP: 1). 30%; 2). 40%; 3). 50%; and 4). 60%. Least squares means for CP and ADF content of the diets were 15.1, 28.2; 14.8, 25.7; 15.5, 29.1; and 15.9, 26.8 for diets 1 through 4 respectively. Diets were formulated such that the RUP was estimated to contain lysine and methionine in a 2.7:1 ratio. Dry matter intake was not different across treatments. Feed efficiency calculated as kg of gain per kg of dry matter intake was 0.25, 0.23, 0.27, and 0.26 for calves consuming treatment diets 1 through 4 respectively. Calves receiving treatment 3 (50% RUP) had greater feed efficiency than calves receiving treatment 1 (30% RUP), ($P < 0.05$) or treatment 2 (40% RUP), ($P < 0.001$). Calves receiving treatment 4 (60% RUP) had greater feed efficiency than those fed treatment 2 (40% RUP), ($P < 0.03$). There was a treatment effect ($P < 0.05$) on body weight gain. Average daily body weight gains (ADG) were 1.02, .96, 1.13, and 1.04 kg for calves consuming treatment diets 1 through 4 respectively. The ADG for calves receiving treatment 3 (50% RUP) was higher than treatment 1 (30% RUP), ($P < 0.06$) and treatment 2 (40% RUP), ($P < 0.006$). In this study, early post-weaned calves fed a 15% CP diet performed best when receiving a diet containing 50% of the CP as RUP.

Key Words: Rumen Undegradable Protein, Heifers, Growth

1049 Effects of dietary vitamin A and E on performance and scour incidence of milk replacer fed calves. B.L. Miller*¹, T.E. Johnson¹, H.B. Perry¹, M.A. Fowler¹, D.E. Housken¹, B.J. Nonnecke², and R.L. Horst², ¹Land O'Lakes, Inc., Webster City, IA, ²National Animal Disease Center, USDA-URS, Ames, IA.

Effects of dietary vitamin A (VA) and E (VE) on performance and scour incidence of milk replacer fed Holstein bull calves were examined. One hundred forty four (144) calves were purchased (34 hr transit) and assigned according to body weight (initial, 42.9 kg) and blood gamma globulin concentration. Calves were fed milk replacer (22% protein, 20% fat) containing 2000 (NRC), 4000 or 34000 IU of VA/d and either 20 or 100 IU of VE/d. Calves were individually housed in crates and fed 2 times daily at 700 and 1615 hours. Weight gains, daily scour score, scour duration and electrolyte/medication costs were calculated weekly and for the 4 wk trial. These data indicate that VA and VE had no effect (P>.05) on calf performance or scouring.

Vitamin A, IU	2000	2000	4000	4000	34000	34000	
Vitamin E, IU	20	100	20	100	20	100	C.V.
Total Gain, kg	12.82	12.89	12.04	12.81	12.84	12.73	16.80
F/G	1.72	1.74	1.88	1.77	1.79	1.79	18.12
Scour Score ^A	1.43	1.36	1.37	1.40	1.40	1.44	15.41
Total Days							
Scouring	10.10	8.27	8.35	9.00	8.61	9.57	49.22
Total Electrolyte/							
Medication, \$	16.83	14.35	16.15	15.92	17.16	19.26	55.59

^A Four week average, 1-4 scale; 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration.

Key Words: Calf, Milk replacer, Vitamin

1050 Effects of dietary vitamins A and E on retinol, retinyl palmitate and vitamin E concentrations in plasma and tissues from neonatal calves. B.J. Nonnecke*¹, R.L. Horst¹, M.A. Fowler², B.L. Miller², J.W. Young³, T.E. Johnson², H.B. Perry², D.E. Housken², and D.A. Hoy¹, ¹National Animal Disease Center, USDA-URS, Ames, IA, ²Land O'Lakes Inc., Webster City, IA, ³Iowa State University, Ames.

Effects of dietary vitamin A (VA) and E (VE) on retinol (ROH), retinyl palmitate (RP), and VE concentrations in plasma, liver and blood leukocytes from neonatal calves were evaluated. Male, Holstein calves entered a 4wk trial at ≤9d of age immediately after being transported for 34h. They were fed milk replacer with 2000 (NRC level), 4000, or 34,000 IU VA/d and either 20 or 100 IU of VE/d. Plasma ROH levels decreased (P<.001) with time in all groups, a possible negative response to shipping. By wk 4, plasma ROH was lower (P<.001) in calves fed ≤4000 IU VA/d (< 62 ng/ml) than in calves fed 34,000 IU VA/d (98 ng/ml). Plasma RP remained low in ≤4000 IU VA/d groups, but increased markedly in the 34,000 IU VA/d group. By wk 4, liver VA (ROH+RP) was lower (P<.001) in ≤4000 IU VA/d groups (< 9 ug/gm) than in the 34,000 IU VA/d group (33 ug/gm). Plasma, liver and leukocyte VA were unaffected by dietary VE. In the 20 IU VE/d group, plasma and liver VE remained low and were unaffected by dietary VA. In contrast, plasma VE was affected (P<0.01) by dietary VA in the 100 VE/d groups. By wk 4, plasma VE in the 2000 IU VA + 100 IU VE/d (2569 ng/ml) and 4000 IU VA + 100 IU VE/d groups (2180 ng/ml) exceeded (P<.05) concentrations in the 34,000 IU VA + 100 IU VE/d group (1681 ng/ml). Similarly, liver VE concentrations were higher (P<.05) in calves fed 2000 (8242 ug/gm) or 4000 IU VA/d (7736 ug/gm) than in calves fed 34,000 IU VA/d (4392 ug/gm). By wk 4, ROH and VE concentrations in leukocytes from the 34,000 IU VA/d group exceeded concentrations (P<.05) in leukocytes from ≤4000 IU VA/d groups. These results suggest that neonatal calves require >4000 IU VA and ≤100 IU VE/d to ensure vitamin adequacy. Although dietary VA altered VE status, this effect was not associated with changes in health or growth.

Key Words: Vitamin A, Vitamin E, Neonatal calf

1051 Effect of dietary vitamin A (VA) and E (VE) on function and composition of circulating leukocyte populations from milk replacer-fed, neonatal calves. B.J. Nonnecke*¹, M.A. Fowler², B.A. Pesch¹, B.L. Miller², R.L. Horst¹, T.E. Johnson², H.B. Perry², D.E. Housken², and J.A. Harp¹, ¹National Animal Disease Center, USDA-ARS, Ames, IA, ²Land O'Lakes, Inc., Webster City, IA.

Fat-soluble vitamin status has been shown to influence broad aspects of the immune systems of a variety of animal species. Previous in vitro studies have shown that metabolites of VA and VE modulate the cellular composition and function of the bovine immune system. In the present study, effects of dietary VA and VE on the function and composition of blood leukocyte populations in neonatal calves were examined. Male, Holstein calves entered a 4wk trial at ≤9d of age immediately after being transported for 34h. During the study period, calves were fed a milk replacer providing 2000 (NRC level), 4000, or 34,000 IU VA/d and either 20 or 100 IU of VE/d. At 4 wk, the composition and function of peripheral blood mononuclear leukocyte (MNL) populations from calves (n=6/treatment group) were evaluated. Flow cytometric analysis of MNL populations indicated that percentages of B cells (P=.74) or T cells [i.e. CD4 (P=.22), CD8 (P=.43), and γδ(P=.47)T cells] or expression of activation antigens [interleukin-2 receptor, (P=.33) and MHC class II antigens (P=.13)] were unaffected by dietary VA and VE. Although DNA-synthesis and secretion of IFN-γ, nitric oxide, and polyclonal IgM by unstimulated and mitogen-stimulated MNL were unaffected (P>.05) by dietary VE, these variables were influenced (P<.05) by dietary VA. Interestingly, VE, but not VA, influenced neutrophil function (i.e. cytochrome C reductase activity, P<.05). Serum Ig (G₁, G, and M) concentrations and total numbers of blood leukocytes were unaffected (P>.05) by VA or VE. These results indicate that dietary VA and VE influence broad aspects of leukocyte function in vitro and suggest that the bioavailability of these vitamins may alter immune competency and disease susceptibility of newborn calves.

Key Words: Neonatal calf, Vitamins A and D, Immune function

1052 The effects of supplemental lactoferrin on calf performance. R.S. Joslin¹, H.M. Santoro¹, N.L. Whitehouse¹, J.J. Rejman², P.S. Erickson*¹, and C.G. Schwab¹, ¹University of New Hampshire, Durham, ²ImmuCell Corp., Portland, ME.

Holstein calves (12 male, 9 female) were used to evaluate the effects of supplemental lactoferrin (Lf) (0, 1, or 10 g) added to colostrum (d1-2) and a commercially available milk replacer (20 % CP, 20 % fat) in a 56-d study. Calves were housed in individual pens, bedded in kiln-dried sawdust, and provided with a coarse calf starter and water ad libitum. Calves were weighed at birth and weekly thereafter. Hip height, body length, and wither height were measured weekly. Fecal scores and rectal temperatures were determined three times per week. Calves were weaned when they consumed 0.7 kg/d of calf starter for two consecutive days. Calves fed Lf tended (P< .10) to consume more starter per day preweaning (0 g, 0.19 kg; 1 g, 0.27 kg; 10 g, 0.31 kg), weighed more preweaning (≤28 to 35 d) (P< .05) (0 g, 44.7 kg; 1 g, 47.1 kg; 10 g, 47.1 kg), and tended (P< .10) to weigh more postweaning (0 g, 58.1 kg; 1 g, 64.2 kg; 10 g, 60.7 kg) compared to calves not receiving Lf. Calves fed Lf had an increased (P< .05) preweaning ADG and average daily heart girth gain compared to control calves with calves fed 1 g Lf having a greater (P< .05) preweaning ADG than calves fed 10 g Lf (0 g, 0.21 kg, 0.11 cm; 1 g, 0.32 kg, 0.19 cm; 10 g, 0.24 kg, 0.16 cm). Calves fed Lf tended (P = .12) to have higher gain/feed preweaning compared to control calves (0 g, 0.29; 1 g, 0.38; 10 g, 0.31). Overall gain efficiency tended (P< .10) to be greater for calves fed 1 g Lf vs. 10 g Lf (0 g, 0.38; 1 g 0.41; 10 g 0.36). Calves fed Lf tended (P< .10) to meet the prescribed weaning criteria at an earlier age (0 g, 33.6 d; 1 g, 31.9 d; 10 g, 31.6 d) compared to control calves. Based on improved growth and starter intake, Lf may be a beneficial additive for young calves.

Key Words: Lactoferrin, Calves, Growth

1053 Growth of calves fed milk replacer containing spray-dried egg product. D. W. Kellogg^{*1}, K. S. Anschutz¹, Z. B. Johnson¹, K. E. Lesmeister¹, and A.K.M.A. Haque², ¹University of Arkansas, Fayetteville, ²American Dehydrated Food, Inc., Springfield, MO.

The nutritional quality of egg protein is recognized, but it has not been tested extensively in milk replacers. Eight male Holstein calves were fed a milk replacer containing spray-dried, feed grade, egg product (49% CP, 37% fat). The medicated milk replacer was a mixture of 30% dried egg product, 36% dried whey, 20% dried skim milk, 10.7% lactose, and 3% poultry fat with vitamins and minerals. All calves were fed a commercially available, medicated milk replacer (20% CP and 20% fat) during a 4-d adjustment period, and the randomly selected control calves (10) were continued on that diet. Nutrient requirements were met or exceeded, including specific amino acid requirements. Fat content was formulated at 15%. Vitamin A, copper, and zinc were fed at elevated levels (121,000 IU, 25 mg/kg, and 100 mg/kg, respectively) since iron content of the dried egg product was 98 mg/kg. Calves were housed in outdoor hutches during the 28-d experiment. Fresh water was offered daily, and supplemental grain was limit-fed (.1 kg/d for week 1, and increased weekly by .1 kg/d) using bottles with specialized nipples. Calves were weighed initially and at weekly intervals. Feed intake was measured daily. Fecal consistency and incidence of treatments for scours were recorded daily. Body weight gains for the 28-d period were similar ($P > .05$) for calves fed milk replacer containing egg protein ($6.1 \pm .8$ kg) and for calves fed the control diet ($6.2 \pm .7$ kg). Control calves tended to consume more grain during week 1 and did consume more grain ($P < .05$) during the 2nd and 4th wk than calves fed milk replacer containing 30% dried egg product. During the 3rd wk the means were not different. There were no major disease problems, and fecal consistency scores were similar for both treatment groups. This experiment indicates that spray-dried egg product can provide protein and fat for dairy calves receiving milk replacer.

Key Words: Dairy Calves, Milk Replacer, Egg Protein

1054 Variable amounts of ruminally degradable and undegradable protein for post-weaned dairy heifers. S. L. Cole^{*1}, C. G. Schwab¹, B. D. Garthwaite¹, N. L. Whitehouse¹, P. S. Erickson¹, T. P. Fairchild¹, and P. C. Hoffman², ¹University of New Hampshire, Durham, ²Marshfield Agricultural Experiment Research Station, WI.

A growth and digestibility experiment was conducted to evaluate the effects of feeding variable levels of RUP and RDP to post-weaned heifers. Forty-two Holstein heifers at 42 d of age (± 3 d) were assigned randomly within blocks to a 2×3 factorial arrangement of treatments. The main effects were percentages of RUP and RDP in diet DM. The six dietary treatments were 1) RUP 5.8, RDP 7.8; 2) RUP 5.8, RDP 9.8; 3) RUP 5.8, RDP 11.8; 4) RUP 8.7, RDP 7.6; 5) RUP 8.7, RDP 9.6; and 6) RUP 8.7, RDP 11.5. All diets contained 30% grass silage, 15.0% chopped grass hay, 34.6% corn meal, 2.0% minerals and vitamins, and 0.1% chromium oxide; targeted RUP and RDP levels were obtained by altering the amounts of soy hulls, soybean meal, non-enzymatically browned soybean meal, and urea. Heifers received treatments until 150 kg BW. Feed intake was measured daily. Skeletal measurements and BW were obtained weekly. Digestibility measurements were obtained on each calf every 3 wk. Intake of DM was not affected by treatment. Feeding the higher RUP diets increased ($P < 0.05$) ADG (0.94 vs. 0.86 kg/d), gain:feed (346 vs. 322 g/kg DMI), and decreased days on treatment (98 vs. 108). Hip height (1.23 vs. 1.12 cm/wk) and heart girth (2.11 vs. 1.95 cm/wk) growth rates also were increased by feeding the higher RUP diets. Effects of higher RUP on growth rates were present until BW approached 110 kg. Increasing RDP increased linearly ADG (0.87, 0.92 and 0.93 kg/d), gain:feed ratios (320, 335, and 346 g/kg DMI) and decreased days on treatment (108, 102, and 99). Increasing RDP also increased linearly total tract digestibility of OM (57.8%, 59.2%, and 63.4%) and non-NDF OM (69.7%, 70.6%, and 76.1%) during the first digestibility period. Heifers < 150 kg BW fed additional RUP responded with increased ADG, feed efficiency, and gain of hip height, and heart girth. Linear increments of RDP increased linearly ADG and feed efficiency.

Key Words: Heifers, Protein, Growth

1055 Effect of physical form of calf starter on starter intake and days to weaning in dairy calves. D. M. Amaral-Phillips^{*}, S. T. Franklin, and A. Polley, University of Kentucky, Lexington.

Weaning of calves should be determined by intake of calf starter. The more readily calves consume starter, the earlier they can be weaned which, in turn, decreases feed and labor costs. The objective of this study was to compare the performance of calves fed a ground, home-mixed calf starter to a commercially-formulated pelleted or textured starter. All starters were isonitrogenous (20% crude protein) and contained equal amounts of lasalocid. The ground starter contained oats, cracked corn, soybean meal, molasses, vitamins and minerals. Thirty calves (10 per treatment) were housed in hutches and fed 2 l of whole milk twice daily. Starter and water were provided free-choice beginning at d 3 of age with starter intake determined daily. Once calves were consuming 0.68 kg starter two days consecutively, milk was fed once daily for 4 days and calves were weaned on d 5. Calves were weighed at birth and weekly for 6 wk. Statistical comparisons were made using the Kruskal-Wallis test. No differences ($P > 0.05$) were detected between treatments in total amount of milk fed or total weight gain over 6 wk (20.9, 18.4, 23.2 kg for ground, pelleted, or textured starter consecutively). Calves fed pelleted starter consumed less total grain over 6 wk compared to the ground or textured treatments (17.6, 11.2, 19.0 kg; ground vs pelleted, $P = 0.09$ and textured vs pelleted, $P = 0.02$). Calves fed pelleted starter were weaned later than calves fed ground or textured starter (31.9, 36.8, 31.1 days; ground vs pelleted, $P = 0.09$ and textured vs pelleted, $P = 0.02$). Calves fed ground or textured starter consumed more starter at an earlier age and were weaned earlier than those fed pelleted starter.

Key Words: dairy calves, starter, weaning age

1056 Carnitine palmitoyltransferase activity in liver of periparturient dairy cows. H. M. Dann^{*}, G. N. Douglas, T. R. Overton, and J. K. Drackley, University of Illinois, Urbana.

Holstein cows were used to determine the effects of diet and physiological state on activity of mitochondrial carnitine palmitoyltransferase (CPT) in liver during the periparturient period. Liver was biopsied at -65 (prior to dry-off), -21, 1, 21, and 65 d relative to parturition. The biopsy at -65 d was used as a covariate. In experiment 1, cows ($n = 39$) were fed either a control (C) or high fat (F) diet from dry-off (60 d before expected calving) to calving at either ad libitum (A) or restricted (R; 80% of calculated NEL requirements) intake. Diets were isocaloric (NEL = 1.43 Mcal/kg). After parturition, all cows were fed the same lactation diet. Activity of CPT (nmol palmitoyl-[3H]-carnitine formed $\cdot \text{min}^{-1} \cdot \text{mg protein}^{-1}$) was 7.9, 11.4, 10.1, and 7.8 (SE = 0.5) at -21, 1, 21, and 65 d relative to parturition, respectively (time effect, $P < 0.0001$). Neither diet (C vs. F) nor feeding level (A vs. R) affected CPT activity, although CPT activity tended ($P < 0.10$) to be greater for C than for F. A tendency ($P < 0.06$) existed for a time by feeding level interaction; cows fed R had greater CPT activity at d 1 but then decreased more rapidly than those fed A. In experiment 2, the cows ($n = 30$) fed C and F diets at A intake were compared with cows fed the control diet with added fat (CF; NEL = 1.58 Mcal/kg) at A intake from dry-off to calving. After parturition, all cows were fed the same lactation diet. Activity of CPT was lowest at -21 d (7.4), highest at 1 d (10.5), and gradually decreased at 21 d (9.4) and 65 d (8.0) relative to parturition (time effect, $P < 0.0001$). Cows fed C had higher ($P < 0.05$) CPT activity than cows fed CF (10.0 vs. 7.7; SE = 0.70); CPT activity for F was intermediate. Time by diet effects were not significant ($P > 0.10$). Significant positive correlations were found between CPT activity and liver contents of total lipid ($n=219$; Spearman rho = 0.40; $P < 0.0001$) and triglyceride ($n=219$; Spearman rho = 0.42; $P < 0.0001$). Day relative to parturition has more pronounced effects on CPT activity than diet composition or feeding level during the dry period.

Key Words: Carnitine palmitoyltransferase, Dairy cow, Transition period

1057 Parturition energy and protein intake of dairy cows. 2. Effect on periparturient lipid metabolism. L. Doepel^{*1}, H. Lapiere², and J.J. Kennelly¹, ¹University of Alberta, Edmonton, Canada, ²Dairy and Swine R & D Centre, Lennoxville, Canada.

Parturition nutrient intake of dairy cows has been shown to affect hepatic lipid accumulation. This study was undertaken to determine the interaction of protein and energy intake in the close-up dry (CUD) period on periparturient lipid metabolism. Twenty-six multiparous Holstein cows were used. Two levels of energy, 1.61 Mcal/kg NE_L (HE) and 1.27 Mcal/kg NE_L (LE), and two levels of protein, 16.3% CP (HP) and 11.1% CP (LP), were tested according to a factorial arrangement in a randomized block design. Treatments began 21 days before expected calving date. After calving, a single diet (1.79 Mcal/kg NE_L, 18.7% CP) was fed. Blood samples were collected by caudal venipuncture 3-5 h after feeding from -3 to +4 weeks relative to calving. Growth hormone (GH) and IGF-1 concentrations were not affected by treatment. Insulin concentrations decreased when energy and protein were uncoupled (energy by protein interaction, P = 0.02). β-hydroxybutyrate (BHBA) concentrations tended to be higher with the HP diets in the postcalving period (period by protein interaction, P = 0.10). Non-esterified fatty acid (NEFA) levels decreased (P < 0.01) with the HE diets. The HP treatment decreased NEFA in the HE diet but increased them in the LE diet (energy by protein interaction, P = 0.03). Liver triglyceride (TG) content on d1 and d21 postcalving tended to be lower (P = 0.08) with the HE than the LE diets. For all metabolites the effect of period was significant (P < 0.05). These data suggest that while CUD nutrient intake does have an effect on lipid metabolism, the physiological changes associated with parturition are far greater.

	Diet				(SEM)	Period	
	HEHP	HELP	LEHP	LELP		CUD	EL*
GH, ng/ml	4.59	4.32	4.12	4.87	0.63	2.03	6.34
Insulin, ng/ml	0.625	0.439	0.420	0.566	0.06	0.78	0.39
IGF-1, ng/ml	84.9	83.9	77.7	86.3	5.62	127.1	63.3
BHBA, mg/dl	12.17	10.17	12.02	11.01	0.98	9.39	11.08
NEFA, μM	355.3	444.1	653.9	531.7	44.2	215.8	423.5
Liver TG, %DM							
day 1	7.06	7.35	11.87	11.40	2.73		
day 21	13.65	11.19	16.03	16.11	2.73		

*EL = early lactation

Key Words: Transition cow, Lipid metabolism

1058 The effects of high inclusion grain mixes fed to transitioning cows on subsequent milk and milk component production. C. M. Luhman^{*}, Land O'Lakes, Inc. and Cooperative Research Farms.

Fifty-seven multiparous Holstein cows that were 14 days prepartum were used in a completely randomized design to compare prepartum rations based on high inclusion grain mixes and forage base. Treatments were: 1) corn silage and grain mix (corn silage; F:C=58:42), 2) haylage + grain mix (haylage, F:C=40:60), and 3) control ration based on a traditional higher forage "steam up" ration (control; F:C=67:33). Rations were fed for 14 days prepartum and cows were then put on a common lactation ration for 28 days; milk production, milk components, and health were followed. Cows fed corn silage or haylage had higher prepartum dry matter intakes than did cows fed control at 1 week prepartum. The prepartum rations based on high inclusion grain mixes allowed for higher production, especially when corn silage is the forage base. Haylage treatment performed as well as or better than the control ration, a traditional "steam up" ration, and both are viable options for transition programs.

	Control	Corn Silage	Alfalfa Haylage	P=
DMI, kg/d	17.8	18.3	18.6	-
Milk, kg/d	37.4 ^b	41.4 ^a	38.6 ^b	0.03
FCM, kg/d	42.8 ^a	47.8 ^b	45.1 ^{ab}	0.04
Milk fat, %	4.47	4.39	4.46	-
Milk protein, %	3.25 ^{ab}	3.14 ^b	3.36 ^a	0.04

1059 Effects of dietary protein prepartum and postpartum on nitrogen balance and milk production from dairy cows. J. M. Moorby^{*}, R. T. Evans, and W. J. Fisher, Institute of Grassland and Environmental Research, Aberystwyth, UK.

Twelve Holstein-Friesian dairy cows were used to investigate the animals' ability to accrete and mobilize protein in the dry period and early lactation. Six dry animals were each offered one of two diets from 6 wk before predicted calving: DL, ad libitum mix of ryegrass silage and barley straw (60:40 DM ratio) with a low diet protein content (10.9 % CP, 2.17 Mcal metabolisable energy (ME)/kg DM), or DH, ad libitum grass silage and 0.5 kg/d high protein maize gluten meal, with a high diet protein content (19.2 % CP, 2.43 Mcal ME/kg DM). After calving, all animals received a standard grass silage based diet for the first 2 wk of lactation. At the start of week three of lactation, all animals received a low protein grass silage TMR diet (LL: 12.8 % CP, 2.42 Mcal ME/kg DM) for 3 wk, designed to force protein mobilization. At the start of week six of lactation, animals were switched to a high protein grass silage TMR diet (LH: 22.3 % CP, 2.62 Mcal ME/kg DM). Forage DM intake was not different among the two dry period diets (mean 8.8 kg DM/d; SE = 0.39), although N balance was significantly affected (6.5 and 69.2 g N/d for DL and DH respectively; SED = 6.67; P < 0.001). All cows were able to mobilize substantial amounts of N during early lactation when given the LL diet, but there was no residual effect of dry period diet (-44 and -53 g N/d for DL and DH; SED = 13.6). When subsequently offered diet LH, animals mobilized less body N (-3 and -29 g N/d for DL and DH; SED = 27.4), with no residual dry period effects, and produced more milk than from diet LL (means of 21.6 and 24.7 kg milk/d for LL and LH; SED = 1.13; P < 0.05). There were no residual effects of dry period treatment on milk production other than increases in protein concentrations from animals previously offered DH (means of 2.92 and 3.10 % for DL and DH; SED = 0.067; P < 0.05). It is concluded that dairy cows can mobilize substantial amounts of body N in early lactation even if dry period protein supply is too low to allow protein accretion.

Key Words: Dry Cows, N Balance, Milk Production

1060 Chronic observation of gravid uterine blood flow around parturition in Holstein cows. T. Nishida^{*1}, S. Ando¹, M. R. Islam¹, Y. Nagao², and M. Ishida¹, ¹National Grassland Research Institute, ²Utsunomiya University Farm.

Blood flow to the gravid uterine horn of seven multiparous Holstein cows (BW = 625.5 pm 82.4 kg; age = 4.7 ± 1.7 years; parity = 2.86 ± 1.07 years) was measured from d 222 of gestation to d 30 postpartum using transit-time ultrasonic blood flow probes placed around the middle uterine artery. Surgery was done at d 215 of gestation. The cows were sedated with xylazine and local anesthesia (procaine hydrochloride) during surgery. The surgical operations were conducted at the flank of standing cows. A transit time ultrasonic flow probe ("S" series, diameter 12 or 14 mm, Transonic Systems Inc., Ithaca, NY, USA) was fitted surgically around the uterine artery of each cow. The animals recovered rapidly following surgery. Uterine blood flow (UBF, liters/min) was recorded at 10 s intervals for 1395 min; these values were averaged to determine UBF. Cows exhibited normal gestation lengths (279.1 ± 7.4 d), gave birth to normal healthy calves (birthweight = 40.6 ± 6.6 kg), and had no retained placentas. The UBF increased significantly (P < 0.01) from d 222 (6.67 ± 2.47) to d 249 (8.23 ± 2.89) of gestation, but the latter UBF was similar to that of d 266 (8.38 ± 2.70). In contrast, UBF declined dramatically after parturition (n = 3) from d 10 (0.29 ± 0.11) to d 20 (0.11 ± 0.026) as well as on d 30 (0.055 ± 0.053). The range of UBF varied widely from 2.93 at d 222 to 13.47 at d 266 of gestation, and from 0.41 at d 10 to 0.0063 at d 30 after parturition. The increased UBF indicates increased demand of nutrients of fetus with the progress of gestation. Our method is useful for chronic measurement of UBF in cows for nutritional or physiological studies and does not require sophisticated facilities or special surgical technique.

Key Words: Blood flow, Uterus, Dairy cows

1061 Metabolic response during the periparturient period of Holstein cows fed varied amounts of dietary protein prepartum. A.F. Park*¹, J.E. Shirley¹, E.C. Titgemeyer¹, M.J. Meyer¹, M.J. VanBaale¹, and M.J. VandeHaar², ¹Kansas State University, Manhattan, ²Michigan State University, East Lansing.

Multiparous Holstein cows (75) were used in a block design to determine the level of dietary protein required prepartum to support metabolic functions and enhance body reserves during the periparturient period. Cows were blocked according to expected calving date and assigned to five diets: 9.7, 11.7, 13.7, 14.7 or 16.2/% CP. Treatments were initiated 28 d prior to expected calving and fed until parturition. Cows were fed a common diet postpartum. Plasma aspartate amino transferase (AST) tended to be higher (quadratic, $P=.12$) prepartum in cows fed 13.7 and 14.7/% CP, but responded linearly ($P=.15$) postpartum with 9.7/% CP leading to the highest activity. AST activity increased from d 1 prepartum to d 3 postpartum by 38%. Peak AST activity occurred on d 3 postpartum for 11.7 and 16.2/% CP, and d 15 in cows fed 9.7/% CP. Prepartum urinary creatinine was not influenced by diet, but postpartum increased linearly with prepartum dietary protein ($P<.01$). Plasma IGF-1 declined by 50% in all cows from d 21 pre through d 3 postpartum and did not differ among diets. Diet effects on IGF-1 during the first 90 d postpartum were primarily due to differential responses to rbST injection. There were no treatment differences for IGF-1 at 60 d postpartum (before rbST), but IGF-1 on d 90 (after rbST) was higher ($P<.01$) for 14.7/% CP than for other diets except 13.7/% CP. Cows fed 13.7/% CP exhibited a lesser IGF-1 response to rbST than 14.7/% CP ($P<.05$) but a greater response than 9.7 and 11.7/% CP ($P<.01$). Plasma glucose was similar among treatments prepartum but lowest postpartum for 16.2/% CP and highest for 14.7/% CP (cubic, $P<.05$). Plasma total alpha-amino nitrogen exhibited a linear ($P=.09$) and cubic ($P<.05$) response prepartum with cows fed 14.7 and 16.2/% CP having highest concentrations. Prepartum plasma urea (PUN) increased linearly ($P<.01$) with dietary protein. Conversely, postpartum PUN was highest in cows fed 9.7/% CP (linear, $P<.01$). Protein level in prepartum diets affects nutrient reserves.

Key Words: Dairy, Aspartate Amino Transferase, IGF-1

1062 Effect of wet corn gluten feed on intake and performance during the periparturient period. A.F. Park, M.J. Meyer, J.M. DeFrain*, J.E. Shirley, E.C. Titgemeyer, T.T. Marston, J.F. Gleghorn, and L.E. Wankel, Kansas State University, Manhattan.

Research was conducted to determine the effect of wet corn gluten feed (WCGF) inclusion during the last 21d of gestation on dry matter intake (DMI) and postpartum performance in eight primiparous (PP) and nine multiparous (MP) Holstein cows. Animals were blocked by parity and randomly assigned to 20/% WCGF (DM basis) or control diet. Treatments were initiated 21d prior to expected parturition and fed until calving with a common diet fed through 28d postpartum. Diet CP % and energy density (Mcal/kg NEL) were 14.3, 1.48 and 13.9, 1.50 for WCGF and control, respectively. Ultrasound techniques were used to determine depth of backfat (BF) and longissimus dorsi (LD). Significance was determined at ($P<.05$) and tendencies at ($P<.15$). Drop in DMI during the last 9d prepartum was 8 and 16/% for MP and 23.2 and 11/% for PP cows fed WCGF and control diets, respectively. DMI and DMI as a % of BW during the last 3d pre- and first 3d postpartum were numerically higher for MP cows fed WCGF. DMI and DMI as a % of BW were numerically lower for PP cows fed WCGF during the entire study. PP cows fed WCGF had higher BW prepartum ($P<.15$) with the inverse being true postpartum. MP cows fed control had higher ($P<.15$) calf birth weights (35.7 versus 47.0kg). Both MP and PP cows fed WCGF prior to calving showed greater ($P<.15$) depth of LD. BF was lower ($P<.15$) postpartum for WCGF fed MP cows. Milk and milk components were not different for MP or PP cows except SCC was higher ($P<.01$) in cows fed WCGF. Plasma glucose, urea nitrogen (PUN), and total alpha amino nitrogen (TAAN) were not different for PP or MP cows. Graphically, PUN increased and TAAN decreased for both PP and MP cows on 1d postpartum, suggesting gluconeogenesis was occurring. These results suggest WCGF has the potential to improve DMI in MP but not PP cows during the last 21d prepartum.

Key Words: Dairy, Periparturient, Wet Corn Gluten Feed

1063 Transition cow: administration of glucose precursors and probiotics. V. Dell'Orto¹, A. Agazzi¹, G. Mancin¹, and G. Savoini*¹, ¹University of Milan, Italy.

In early lactating cows energy intake is not sufficient to satisfy the requirements for maintenance and milk production. To reduce the negative energy balance in transition cows, the administration of glucose precursors such as propylene glycol, glycerol and probiotics could be useful. Twenty-four multiparous Friesian cows were divided into two groups (treatment=T and control=C) on the basis of parity. All cows received the same basal diet. Starting on 3d before and continuing until 5d after calving, T cows were administered daily 500 ml of a supplement containing: propylene glycol, glycerol, 1-6 diphosphate glucose dextrose and *Saccaromyces cerevisiae*. Blood samples were collected at 2d before and 4d, and 15d after calving and subsequently analyzed for glucose, NEFA, BHBA and plasma concentration. Milk production was recorded at 4d, 7d and 15d after calving. Body Condition Score (BCS) was evaluated at 60d, and 2d before and 4d, 7d and 15d after parturition. Data were analyzed by ANOVA using the GLM procedure. Plasma NEFA concentration peaked at 4d after calving in C and T cows; however no significant difference was observed between groups. Treatment did not influence plasma glucose concentration, which decreased from 2d before to 4d after calving in all cows. Milk yield was significantly higher in T cows at 4d (38.44 kg vs 35.67 kg) ($P\leq.01$) and 7d (39.78 kg vs 37.44 kg) ($P\leq.04$). During the dry period the BCS did not differ between groups (average=3.7). At 15d of lactation BCS tended to be higher in T cows (3.43 vs 3.25) ($P=0.1$). No clinical sign of ketosis was detected in C and T groups. The administration of glucose precursors and *Saccaromyces cerevisiae* to transition cow allowed an increase of milk yield without any negative effect on NEFA, BHBA, and glucose plasma concentration.

Research supported by MURST 40% Dell'Orto.

Key Words: Transition cow, Propylene glycol, Probiotics

1064 Metabolic effects of propylene glycol in transition diets of Jersey cows. M. Birchen*, B.A. Fadl-Alla, M.R. Murphy, G.C. McCoy, and M.F. Hutjens, University of Illinois, Urbana.

Twenty multiparous and twenty primiparous Jersey cows were assigned (based on age, calving date, and previous production) to either control or propylene glycol-treated groups. The propylene glycol treated group was drenched with 228 grams of propylene glycol daily from 7d prior to the projected calving date to 7d postpartum. Blood was sampled 8d prior to projected calving date, every 3 to 4d days until calving, the day of calving, 7d postpartum, and 14d postpartum. Blood plasma glucose and β -hydroxybutyrate concentrations were measured. Dry matter intake, milk production, body condition score, body weight, and milk composition were also determined. No differences between groups for dry matter intake, milk production, milk composition, or body condition score were observed. However, body weight loss was slowed in cows drenched with propylene glycol. Blood glucose concentrations for the propylene glycol-drenched group (80 mg/dl) were significantly higher ($P<0.0001$) on the day of calving than the control group (65 mg/dl). Blood glucose concentrations were numerically higher in treated cows 7d after drenching was discontinued. The level of β -hydroxybutyrate levels remained lower in propylene glycol-drenched animals from calving until 14d postpartum. Drenching propylene glycol can alleviate subclinical ketosis in Jersey cattle.

Key Words: Ketosis, Propylene glycol, Transition diet

1065 Blood, ruminal and fecal measures of steers fed different combinations of supplemental energy and DIP while grazing winter range. T. N. Bodine*, H. T. Purvis II, and D. A. Cox, Oklahoma Agricultural Experiment Station, Stillwater.

Fifty-two steers (286 \bar{n} 7 kg initial BW) and 8 ruminally cannulated steers (496 \bar{n} 14 kg) were individually fed 1 of 4 supplements 5 d/week while grazing dormant native tallgrass prairie for 98 d. Supplements were: 1) CORNSBM, corn and soybean meal, balanced for total diet DIP:TDN, 2) CORN, corn and soybean hulls, equal supplemental TDN to CORNSBM, 3) SBM, soybean meal, equal supplemental DIP to CORNSBM, or 4) CONT, cottonseed hull-based control. Supplements were fed at a rate of 13, 13, 4, or .6 g DM/(kg steer BW*feeding), respectively. Weights, fecal grab samples and blood samples were taken monthly within one hour of feeding on the fifth of five consecutive days

of feeding. Fecal samples were analyzed for pH and concentrations of N and ADF. Serum from blood samples was analyzed for urea nitrogen and insulin. Steers fed CORNSBM, CORN and SBM vs CONT-fed cattle increased ($P=.01$) ADG (.77, .29, .48, .05 kg), serum insulin (3, 2.5, 2.5, 2.3 ng/dl), fecal N (2.6, 2.4, 2.3, 2%) and ruminal $\text{NH}_3\text{-N}$ (5.2, 6.7, 9, 1.3 mg/dl). Steers fed CORNSBM had greater ($P<.01$) ADG, insulin and fecal N than those fed CORN or SBM. Steers fed supplements with corn (CORNSBM, CORN) had decreased ($P=.01$) ruminal pH (6.1, 6.1, 6.4, 6.4), acetate:propionate (3.6, 3.8, 4.8, 5.2) and acetate (68, 68, 73, 76%) and increased ($P<.01$) propionate (19, 18, 15, 15%) than those not fed supplemental corn (SBM, CONT). Corn-fed cattle had lesser ($P<.01$) fecal pH (5.7, 5.8, 6.8, 6.8) and ADF (26, 27, 38, 40%) than those steers not consuming grain. Cattle fed supplements with soybean meal (CORNSBM and SBM) had greater ($P<.01$) serum urea nitrogen (11.4, 16.5, 4.9, 5.6 mg/dl) than those without soybean meal (CORN, CONT). Stocker cattle grazing dormant native range had the greatest response in animal performance and physiological measures when supplements were balanced for ruminally degradable protein and energy.

Key Words: Grazing Beef Cattle, Physiological Measurements, Degradable Intake Protein

1066 Effects of hay and(or) protein supplementation with pelleted soybean hulls on growth performance of growing steers. J.A. Shiver*¹, D.L. Lalman¹, D.R. Gill¹, R.L. Ball¹, J.N. Carter¹, W.T. Choat¹, S.D. Carter¹, G.W. Horn¹, and T.C. Stovall¹, ¹Oklahoma State University, Stillwater.

Seventy-eight crossbred steers (190 kg initial BW) were allotted by weight block to three dietary treatments (5 pens/trt of five steers/pen) to evaluate the effects of hay and(or) protein supplementation to a pelleted soybean hull diet. Steers were housed in 4.6 x 9.1 meter dirt floor pens with the feeding area and concrete apron covered. Cattle were weighed prior to feeding every twenty eight days to determine average daily gain(ADG). Feed intake and feed refusals were recorded daily. Dietary treatments were: 1) ad libitum access to soybean hulls (CON), 2) CON plus .9 kg /hd/day supplement (TRT2), and 3) TRT2 plus .68 kg/hd/day long stem prairie hay (5.7% CP, 69.3% NDF and 40.9%ADF, DM basis)(TRT3). Soybean hulls contained 9.6% CP, 63.4%NDF and 48.7% ADF, DM basis. Protein requirement was estimated assuming 1.11 kg weight gain per day using 1996 National Research Council feed energy values. Protein supplement was formulated using a blend of soybean meal, cottonseed meal, wheat middlings, and vitamins and minerals, it contained 32% CP. Daily weight gain, feed DMI and G:F was .96, 1.11, 1.23 kg; 6.7, 7.25, 7.61 kg; and .165, .164, .144 for CON, TRT2 and TRT3, respectively. Daily gain was increased by addition of supplement and hay ($P<.01$). Feed intake was similar when supplement was fed but increased ($P=.02$)when hay was fed. Total diet feed efficiency was not improved with supplement and decreased ($P<.01$) when hay was fed. Protein content of soybean hulls fed in this study were not sufficient to meet the requirements of growing steers gaining over 1 kg per day. These results demonstrate the potential for increased growth performance when feeding ad libitum soybean hulls with the addition of a protein supplement and long stem prairie hay to growing steers.

Key Words: Soybean Hull, Ad Libitum, Growing Steers

1067 Relative efficiency of 40 or 160 g of moderate or high undegradable intake protein supplements with low quality forage diets. J. E. Sawyer*, C. C. Rasor, R. C. Waterman, and M. K. Petersen, *New Mexico State University, Las Cruces, NM USA.*

A study comparing the relative efficiency of supplement utilization among different amounts of two protein sources, based on in situ forage DM disappearance, ruminal NH_3 and serum urea nitrogen (SUN) accumulation, serum glucose, and nitrogen (N) concentration in duodenal contents, was conducted using a 4X4 Latin Square. Four dually cannulated steers were restricted to 6.8 kg/d sudan hay (3.7% CP) in addition to 56 g salt-mineral (CON), CON+40 g CP from cottonseed meal (LCS), CON+160 g CP from cottonseed meal (HCS) or CON+40 g CP from a blood and feather meal combination (BFM) during 14 d periods. In situ DM disappearance after 24 h was greater in supplemented animals ($P<.1$), but was similar for BFM compared to HCS or LCS ($P>.2$). Disappearance was 35.4, 39.5, 37.3 and $37.2\pm 1.1\%$ for

CON, HCS, LCS, and BFM. Ruminal ammonia concentrations were influenced by supplementation ($P<.05$). HCS induced greater ruminal ammonia accumulation than BFM ($P<.01$) while BFM and LCS resulted in similar ammonia concentrations ($P>.2$). Serum urea nitrogen concentrations followed a trend reflecting ruminal ammonia. SUN was influenced by supplementation ($P<.01$), with HCS increasing SUN more than BFM ($P<.02$) and LCS and BFM exerting similar effects ($P>.4$). Serum glucose concentrations were increased with protein supplementation ($P<.01$) but did not differ among supplemental treatments ($P>.2$), indicating that more gluconeogenic precursors were available when additional protein was provided. Concentration of N in duodenal contents was increased by supplementation ($P=.06$), with no statistical difference observed between supplements ($P>.4$). Nitrogen concentrations in duodenal contents (mg N/g wet contents) were .69, .87, .79, and $.86\pm .055$ for CON, HCS, LCS, and BFM. In conclusion, 40 g of protein supplement improved utilization of low quality forages. The marginal response to an additional 120 g of protein was diminished. These data suggest that due to improved efficiency, low levels of supplement may be as effective as higher amounts when fed with low quality forages.

Key Words: protein, supplementation, efficiency

1068 Effects of supplementation of limit-fed growing diets with either soybean meal or non-enzymatically browned soybean meal on steer performance. C. M. Coetzer*, J. S. Drouillard, S. P. Montgomery, T. B. Farran, J. J. Sindt, A. M. Trater, H. J. LaBrune, R. D. Hunter, and T. A. Nutsch, *Kansas State University, Manhattan.*

Eighty individually fed Angus x Hereford steers (295 kg) were used to evaluate the effects of supplementing limit-fed, wheat middling or soybean hull-based diets with either soybean meal (SBM) or non-enzymatically browned soybean meal (NSBM) on growing steer performance. Steers were stratified by weight and randomly allotted, within strata, to one of ten treatments. The CP content of a wheat middling-based control diet (16.0% CP) was increased by 2.6 and 5.2 percentage units using SBM or NSBM to make up the first five treatments. The CP content of a soybean hull-based control diet (15.6% CP) was increased by 2.6 and 5.2 percentage units using SBM or NSBM to make up the remaining five treatments. Steers were fed once daily for 84 days at 1.8% of BW. Data were analyzed by regression using supplementation level as a continuous variable, nested within supplement source (SBM or NSBM). Average daily gain and efficiency did not change with increasing level of SBM among the wheat middling-based diets. However, gain and efficiency increased linearly ($P<0.05$) with increasing level of NSBM ($\text{ADG}=.992 - .00398(\text{increase in \% CP from SBM}) + .0197(\text{increase in \% CP from NSBM}); \text{gain:feed}=.166 - .000659(\text{increase in \% CP from SBM}) + .00325(\text{increase in \% CP from NSBM})$). Average daily gain and efficiency increased ($P<0.05$) when the CP content of the soybean hull-based control diet was increased by 2.6 percentage units using SBM or NSBM. However, increasing the CP content by 5.2 percentage units did not further increase performance. Supplementation with NSBM, but not SBM, improved performance of growing steers fed restricted amounts of wheat middling-based diets. These data suggest that undegraded intake protein may be first limiting in high-concentrate, limit-fed growing diets composed of wheat middlings.

Key Words: Non-enzymatically Browned Soybean Meal, Limit-Feeding, Beef Cattle

1069 Evaluation of performance in receiving heifers fed different sources of dietary lipids. T.B. Farran, J.S. Drouillard, D.A. Blasi, H.J. LaBrune, S.P. Montgomery, J.J. Sindt, C.M. Coetzer, R.D. Hunter, T.A. Nutsch, and J.J. Higgins, *Kansas State University, Manhattan.*

High stress crossbred beef heifers ($n=501$, 201 kg) of Southeast origin were used in a 35-d receiving trial to evaluate average daily gain, feed intake, and efficiency when fed diets containing different sources of lipid. Cattle were provided grass hay and water on arrival and were processed within 24 h. Cattle were implanted, vaccinated against common viral and clostridial diseases, treated for internal and external parasites, and given a metaphylactic dose of tilmicosin (0.33 ml/kg BW) at processing. Heifers were individually weighed and randomly assigned to pens containing six to seven animals with twenty-six pens per treatment. Treatments consisted of diets containing different lipid sources by adding ground flaxseed (FLX), rolled full-fat soybeans (SOY), and

tallow (TAL) at 13, 20, and 4%, respectively (DM basis). Heifers were revaccinated, weighed, and rectal temperatures were recorded on d 7. ADG for the first seven days was greater ($P < 0.01$) for FLX and TAL than for SOY (0.71, 0.58, 0.11 kg/d for FLX, TAL, and SOY, respectively). The reduction in mean rectal temperature by d 7 was greater for FLX ($P < 0.05$) and SOY ($P = 0.10$) compared to TAL, but SOY and FLX were not different ($P > 0.50$). ADG for the 35-d receiving period were 1.24, 1.14, 0.88 kg/d and gain efficiencies were 0.257, 0.241, and 0.207 kg gain/kg DM for FLX, TAL, SOY, respectively. ADG and DM intake were greater ($P < 0.01$) for FLX and TAL compared to SOY. Gain efficiency also was greater for FLX ($P < 0.01$) and TAL ($P = 0.07$) compared to SOY. Manipulating diets to contain different lipid sources may alter performance in highly stressed receiving cattle.

Key Words: Receiving cattle, Lipids

1070 Bloodmeal increases performance of early-weaned calves late in the growing phase. J. W. Lehmkuhler*¹ and M. S. Kerley¹, ¹University of Missouri, Columbia.

Increasing the post-ruminal flow of amino acids was hypothesized to improve the performance and efficiency of early-weaned steer calves. Thirty-six crossbred steers were weaned at an average of 114 d (avg. wt. = 161 kg) and blocked by age. Steers were implanted with Revelor-S[®], dewormed, and vaccinated with a four-way modified live vaccine on d 0 and reimplanted on d 113. Treatments were randomly assigned to 12 pens (3 steers/pen). Treatments tested were the replacement of corn with bloodmeal (BM) at 0, 5, 10, or 15% on a DM basis. The 0% diet consisted of 52.2% corn, 15% corn silage, 20% soybean hulls, 10% soybean meal, and 2.8% mineral/vitamin mix on a DM basis. Diets were sampled weekly and analyzed for DM, CP, ADF, and ash. Diets averaged 70% DM and 6% ash while CP for the treatments was 14.2%, 19.6%, 24.9%, and 31.1% for 0, 5, 10, and 15% BM, respectively. The study lasted 181 d and steers (474 kg) were shipped to a commercial slaughtering facility at an average age of 10 months. Steers yielded an average 293 kg hot carcass with 1.3 cm backfat, 76.1 cm² ribeye area, 3.3% kidney, pelvic, and heart fat, yield grade 2.8, and average to high select quality grade. The overall average DMI was lower ($P < .05$) for 10% and 15% BM (8.6 and 8.2 kg) compared to 0% and 5% (9.3 and 9.2 kg). ADG was greater ($P < .05$) for the 5% BM group at 1.9 kg than the other treatments (1.8 kg) for the entire study. Differences in ADG were found to be greater the last 67 d. Inclusion of 5% BM improved gain ($P < .05$) compared to the control diet by 12.7% during the last 67 d. No differences in ADG were noted between treatments early in the study. Overall feed efficiencies were similar ranging from 4.6-5.3. Calculated efficiency of NEg utilization was improved 12% by the addition of 5% BM and 16% for 15% BM compared to the 0% diet. Increasing the amount of amino acids available at the small intestine via BM improved performance and efficiency of early-weaned calves late in the growing phase. We inferred that post-ruminal amino acid supply for finishing cattle is limiting on traditional diets.

Key Words: Undegradable intake protein, Cattle, Early-wean

1071 Effects of feeding fat and normal vs. high oleic acid soybeans on feedlot steer performance and carcass characteristics. E. E. D. Felton*¹, C. L. Lorenzen¹, M. S. Kerley¹, S. D. Soderlund², and F. N. Owens², ¹University of Missouri, Columbia, ²Optimum Quality Grains, Des Moines, IA.

A 76d study was conducted to determine whether vegetable or animal fat would have an influence on improving feedlot steer performance. Whole raw soybeans, bin-run (NORM) or high oleic acid content (HO) were also compared for their effects on steer performance. Angus-crossbred steers ($n = 72$) were randomly allotted to treatments (initial wt = 443.58 ± 1.00 kg) with 6 steers/pen. Dietary treatments were a control (T1), NORM replacing all soybean meal (SBM) (T2), HO replacing all SBM (T3), and the control diet plus addition of choice white grease equal to the EE of the soybean containing rations (T4). All diets were isonitrogenous and contained equal amounts of corn silage, soyhulls, limestone, NaCl, trace-mineral and vitamin premixes, Rumensin[®] and Tylan[®]. No differences ($P > .05$) were observed in total weight gain (130 kg), ADG (1.7 kg/d) or hot carcass weight (347 kg). Likewise, no statistical differences ($P > .05$) were detected in ribeye area (79.42 cm²), tenth rib backfat (13.2 mm), yield grade (3.3) or % boneless retail cuts (48.76). Linear contrasts revealed differences ($P < .05$) in feed to gain (T1-8.02, T2-7.54, T3-7.41 & T4-7.23) and marbling (T1-slight⁶⁶, T2-slight⁹², T3-slight⁹¹

& T4-slight⁹⁰) with the addition of fat (8.02 vs. 7.39 and slight⁶⁶ vs. slight⁹¹, respectively for control vs. fat). Source of fat had no effect ($P > .10$) on any parameters measured. We inferred that the addition of vegetable or animal fat to the diets of finishing steers can improve feed efficiency and marbling. These data further suggested that the performance of steers consuming diets containing genetically modified soybeans is unhindered.

Key Words: Soybeans, Fat, Cattle

1072 Influence of dietary starch source on fatty acid synthesis and the expression of fat metabolism genes in bovine adipose tissue. E. Okine*¹, D. R. Gimm², G. R. Khorasani², and J. J. Kennelly², ¹Western Forage/Beef Group, Lacombe, AB, Canada, ²University of Alberta, Edmonton, AB, Canada.

The hypothesis of this study was that different sources of dietary starch with different ruminal rates of degradation would influence parameters of fat metabolism and the fatty acid composition of bovine adipose tissue (BAT). We evaluated the expression of fatty acid synthase (FAS) and acetyl-CoA carboxylase (ACC) genes, the abundance of their respective proteins, and characterized the fatty acid composition of adipose tissue. Four barley grain varieties (Brier, Candle, Noble, and Oxbow) were compared to a corn grain. The ruminal rate of dry matter degradation for the Brier, Candle, Noble, and Oxbow barley varieties, and corn were 33.9, 29.0, 48.6, 47.9, and 6.5% per hour, respectively. Five Holstein heifers (456 ± 8.0 kg) were fed diets containing 35% barley silage and 65% concentrate in a 5 × 5 Latin square design experiment. The barley diets contained 59% barley grain and the corn-based diet contained 51% corn to achieve similar starch contents. Dry matter intake tended to be higher for heifers fed the corn diet (10.6 kg/d) compared to the Brier barley variety (7.7 kg/d, ($P = 0.09$), but did not differ among the other dietary treatments. The concentration of C_{14:0} fatty acid in BAT was 8% ($P < 0.05$) higher for heifers fed the Brier variety of barley compared to the corn diet, but did not differ among the other dietary treatments. Dietary starch source had no effect on the abundance of ACC protein and mRNA in adipose tissue. However, the abundance of the FAS protein was about 3 times ($P < 0.05$) higher in adipose tissue of heifers fed Brier compared to the Oxbow variety. The expression of FAS mRNA was ($P < 0.05$) higher in adipose tissue of heifers fed diets with Candle and Noble barley varieties compared to the Oxbow variety. We conclude that different sources of dietary starch may affect fat metabolism in bovine adipose tissue through influences on gene expression and FAS enzyme kinetics.

Key Words: Starch Source, Adipose Tissue, Fatty Acid Synthesis

1073 Effect of management strategy on average daily gain, carcass traits, and fatty acid composition in longissimus muscle of finishing steers. L. F. Laborde, I. B. Mandell*, J. J. Tosh, J. G. Buchanan-Smith, and J. W. Wilton, University of Guelph, Ontario, Canada.

The objective of this study was to evaluate the effect of management strategy on performance, carcass characteristics, and fatty acid composition of total lipids (TL) and phospholipids (PHL) from longissimus muscle in crossbred steers ($n = 136$) sired from either Angus or Simmental bulls. Weaned cattle were finished under one of two management strategies: 1) high grain finishing with a 77% corn, 15% alfalfa silage diet fed ad libitum until slaughter (HG); and 2) backgrounding with a 100% alfalfa silage diet fed at 1.9% of BW for 112 d followed by feeding the HG diet ad libitum until slaughter (BKG). Data were adjusted to a 10-mm backfat (grade fat) endpoint in statistical analyses. Steers on the BKG regime spent 64 more ($P < .001$) days on feed but had lower ($P < .001$) average daily gain and smaller ($P = .01$) longissimus muscle area as compared to steers on the HG strategy. Management strategy did not affect ($P > .15$) weights at slaughter, intramuscular fat percentage, and subjective marbling score. For TL, backgrounding decreased ($P < .05$) concentrations of myristic acid, stearic acid, and total saturated fatty acids (SFA), and increased ($P < .05$) total monounsaturated fatty acids (MUFA) and conjugated linoleic acid (CLA) when compared to steers on the HG regime. For both TL and PHL, backgrounded cattle had lower ($P < .05$) concentrations of linoleic acid, arachidonic acid, and total omega-6 ($\omega 6$) polyunsaturated fatty acids (PUFA), higher ($P < .001$) percentages of individual and total omega-3 ($\omega 3$) PUFA, and lower ($P < .001$) $\omega 6$: $\omega 3$ ratio, than steers directly placed on grain after weaning. Backgrounding increased deposition of MUFA, $\omega 3$ PUFA and

CLA, desirable for promoting human health, while decreasing deposition of less desired SFA and ω 6 PUFA.

Key Words: Beef Cattle, Backgrounding, Fatty Acids

1074 Effect of method of diet adaptation on animal performance and carcass characteristics of beef steers. W.T. Choat¹, M.S. Brown², C.R. Krehbiel^{*1}, G.C. Duff³, D.A. Walker³, K.J. Malcolm-Callis³, and M.W. Wiseman³, ¹Oklahoma State University, Stillwater, ²West Texas A&M University, Canyon, ³Clayton Livestock Research Center, Clayton, NM.

Seventy-three Angus x Hereford steers (415 ± 64 kg) were used in a completely random design to determine the effects of method of high-concentrate diet adaptation on animal performance and carcass characteristics during a 70-d feeding period. Conventional steers ($n = 4$ pens; 9 or 10 steers/pen) were adapted to a 90% concentrate diet using five adaptation diets of 70, 75, 80, 85, and 90% concentrate. Steers were fed each diet for five d until adapted to the 90% concentrate diet. Initial level of intake was set at 2% of BW (as-fed basis) and increased .45 kg/steer when a slick bunk was evident. Restricted steers ($n = 4$ pens; 9 steers/pen) were adapted using the 90% concentrate diet; initial level of intake was set at 0.5% of BW (as-fed basis), and increased 0.23 kg/steer when a slick bunk was evident. Steers were weighed (unshrunk) and period DMI was calculated on d 14, 28, 56, and 70. Overall ADG was calculated from BW on d 0 and 70 and reduced 4% for gastrointestinal fill. Overall ADG did not differ ($P=.21$) due to starting method (1.81 vs $1.73 \pm .06$ kg/d, respectively), although DMI from d 0 through 70 was increased ($P<.05$) for conventional steers compared with restricted steers. Overall, ADG:DMI was 5.1% greater ($P=.09$) for restricted steers (.178) than for conventional steers (.169). Although final BW did not differ (564 vs 559 ± 6 kg), conventional steers had increased ($P=.04$) hot carcass weights (343 vs 335 ± 2 kg) and greater ($P=.04$) internal fat (2.26 vs $2.13 \pm .04\%$) than restricted steers. During adaptation to a high-concentrate diet, our data suggest more efficient conversion of feed to gain and less internal fat by restricting intake of a high-concentrate diet compared with the traditional altering of forage:concentrate.

Key Words: High Grain, Cattle, Diet Adaptation

1075 Effects of previous grazing on feedlot cattle performance and carcass characteristics. W.T. Choat^{*1}, C.R. Krehbiel¹, G.C. Duff², R.E. Kirksey³, D.A. Walker², K.J. Malcolm-Callis², M.W. Wiseman², L.M. Lauriault³, and G.B. Donart⁴, ¹Oklahoma State University, Stillwater, ²Clayton Livestock Research Center, Clayton, NM, ³Agricultural Science Center, Tucumcari, NM, ⁴New Mexico State University, Las Cruces.

The effects of winter grazing on gain, subsequent finishing performance, and carcass characteristics of 67 crossbred steers (231 kg \pm 21 kg) were evaluated in a completely random design. At weaning, steers were stratified by weight and allotted randomly to graze either winter wheat (WW; 43 steers) or dormant native range (NR; 24 steers). On May 10, 1999 steers were placed in a feedlot and assigned randomly (within previous treatment) to three (NR) or four (WW) pens. Steers were adapted to a 90% concentrate diet using 5 adaptation diets. Steers were fed each diet for 5 d until adapted to the 90% concentrate diet. Initial intake was set at 2% of BW (as-fed basis) and was increased .45 kg/steer when a slick bunk was evident. Steers which had grazed WW were fed for 70 d, whereas steers which grazed NR were fed for 126 d. Steers were weighed individually and period DMI was calculated for d 14, 28, 56, 70(wheat), 84, 112, and 126. During winter grazing, WW and NR grazed steers gained 1.05 and $.32$ kg/d, respectively. During finishing, overall ADG (1.92 vs $1.81 \pm .064$ kg/d) and feed:gain (4.54 vs $6.36 \pm .21$) favored ($P<.05$) steers which had grazed NR compared with steers which had grazed WW. Steers grazed on WW and NR yielded 88.4% and 87.5% U.S. choice carcasses, respectively. Hot carcass weight was not different ($P>.10$), but steers grazed on WW had higher ($P<.05$) marbling scores (480 vs 440), less subcutaneous fat (1.3 vs 1.7 cm), larger longissimus area (78 vs 74 cm²), greater internal fat (2.26 vs 1.92%), and a lower numerical yield grade (3.25 vs 3.61) than steers grazed on NR. Although compensatory growth occurs for steers wintered on NR, growing steers on WW prior to finishing results in more favorable carcass traits.

Key Words: Winter Wheat, Dormant Forage, Carcass Traits

1076 Influence of previously grazed winter wheat or native range on nutrient digestion by growing bovine being adapted to a 90% concentrate diet. W.T. Choat^{*1}, C.R. Krehbiel¹, G.C. Duff², J.D. Rivera², D.A. Walker², K.J. Malcolm-Callis², M.W. Wiseman², and B.J. Summers¹, ¹Oklahoma State University, Stillwater, ²Clayton Livestock Research Center, Clayton, NM.

Eight ruminally cannulated steers which had previously grazed winter wheat (WW; $n = 4$; initial BW = 407 ± 12 kg) or dormant native range (NR; $n = 4$; initial BW = 293 ± 23 kg) were used to determine intake, digesta kinetics, and total tract digestion while being adapted to a 90% concentrate diet. The adaptation included a series of 5 diets of 70, 75, 80, 85, and 90% concentrate. Steers were fed each diet for 5 d until adapted to the 90% concentrate diet. Chromic oxide (15g/d) was dosed ruminally (0730) via gelatin capsules as an indigestible marker of digesta flow throughout the 30-d experiment. Fecal grab samples were collected daily on d 7 through 10, 17 through 20, and 27 through 30. On d 5, 15, and 25, steers were dosed intraruminally at 0730 with 200 mL of Co-EDTA. Ruminal fluid samples were obtained at 0, 3, 6, 9, 12, 18, and 24 h after dosing. Ruminal contents were removed, weighed, subsampled, and returned to the rumen on d 17 and 27. Throughout the adaptation period, DMI (g/kg of BW) was greater ($P<.05$) for steers that grazed NR compared with WW. In addition, total tract OM, starch, ADF, and N digestibilities were greater ($P<.05$) for steers which had grazed NR compared with WW while consuming the 75% concentrate diet. No differences in total tract digestibilities were observed ($P>.10$) when steers were consuming 85 or 90% concentrate. Ruminal liquid and DM fill (g/kg of BW) were numerically greater ($P>.10$) when steers were consuming 80% concentrate, and were greater ($P<.05$) when steers were consuming 90% concentrate for steers grazed on NR vs WW. Fluid passage rate generally did not differ among treatments. Improved total tract digestibility of nutrients early in the finishing period, partially attributable to greater ruminal volume, might result in a compensatory growth response by steers grazed previously on low-quality compared with high-quality forage.

Key Words: Cattle, High Grain Diets, Digestibility

1077 Effect of animal grouping on feeding behavior and intake of dairy cattle. R. J. Grant^{*1} and J. L. Albright², ¹University of Nebraska, Lincoln, ²Purdue University, West Lafayette, IN.

Dry matter intake is the major factor influencing milk production and energy balance during lactation. Grouping strategy and subsequent group feeding behavior that influence dry matter intake have a potentially tremendous impact on cow productivity and farm profitability. The design of the feeding system, feeding management, and dietary formulations must recognize the dynamic nature of dairy cow psychology and physiology, nutrient requirements, and variability in feedstuff composition. Improperly grouping dairy cows perturbs the normal behavioral routines and time budgets. Grouping should not only minimize negative social interactions, but proper grouping strategy will also decrease within-group variation and increase across-group variation. A more homogeneous group of cows makes proper ration formulation easier. Feeding behavior has a substantial impact on dry matter intake, particularly for the transition cow. The transition cow is especially vulnerable to excessive competition for feed and other resources. Although feeding behavior is controlled by gut fill and chemostatic mechanisms, intake is modulated by management factors such as grouping strategy which interacts with feeding and housing facilities.

Key Words: Feeding behavior, Dry matter intake, Dairy cattle

1078 Relationships of body weight and condition of Holstein cows with performance traits during the periparturient period. A.F. Park^{*}, J.E. Shirley, M.J. Meyer, M.J. VanBaale, and E.C. Titgemeyer, Kansas State University, Manhattan.

This data was from a study evaluating amount of prepartum dietary protein on pre- and postpartum performance of dairy cows (75). Trial groups were balanced for bodyweight (BW), body condition score (BCS), and previous lactation milk yield (PMY). Initial BCS, BW, and PMY were not different among groups and averaged 2.91 (range 2.25 to 4.5), 670 kg (range of 520 to 875), and 10,843 kg (range 7,721 to 14,017), respectively. Measurements were initiated 28 d prior to expected calving date and a common diet fed postpartum. The relationships of BW

and BCS with individual cow data, irrespective of parturient diet, were evaluated due to their significant impact on cow data during this period. The mixed procedure of SAS was used for analyzing responses to dietary treatments with initial BCS, BW, and PMY included as covariates with significance at ($P < .05$) required for covariates to be retained in the model. The BW of cows at the initiation of study (28 d pre-calving) was related positively to pre- and postpartum DMI ($P < .01$). However, cows with the highest initial BW experienced the largest intake drop during the last 3 d prior to calving ($P < .05$). Conversely, initial BCS was related negatively to pre- and postpartum DMI ($P < .01$), but BCS was not related to the magnitude of the drop in DMI observed prepartum. Pre- and postpartum energy balances were related negatively to initial BCS ($P < .01$). Initial BW was related positively ($P < .01$) to milk yield, peak milk yield, kg milk/kg DMI, kg lactose, kg SNF, and kg milk fat during the first 90 d postpartum, but negatively ($P < .01$) to kg milk protein. Initial BCS was related negatively ($P < .05$) to milk yield, kg milk fat, kg milk protein, kg lactose, SNF percent and yield, peak milk yield, and days to peak milk. Initial BW and BCS significantly influenced the performance of Holstein cows. In general, BW was related positively, and BCS negatively, to production; these relationships appeared to be mediated primarily through their impacts on feed intake.

Key Words: Body Condition, Dairy, Periparturient Period

1079 Liver metabolism and production of periparturient dairy cattle fed rumen-protected choline. M. S. Piepenbrink* and T. R. Overton, *Cornell University, Ithaca, NY.*

Forty-eight Holstein cows entering second or greater lactation were used to determine whether liver metabolism and production are affected by supplementation with choline during the periparturient period. Cows were fed common closeup dry and lactating TMR topdressed with either 0, 45, 60, or 75 g/d of rumen-protected choline (RPC; Reashure™ choline, Balchem Corporation, Slate Hill, NY) from 21 d before expected calving until 63 d after calving. Liver samples were obtained via biopsy before assignment to treatment, and 1 and 21 d after calving, and used for metabolic incubations and compositional analysis. Rates of conversion of [^{14}C]palmitate to CO_2 were not affected by treatment (80, 76, 69, 75 nmoles/(hour \times g wet weight); $P > 0.15$). Rates of conversion of [^{14}C]palmitate to intracellular esterified products decreased linearly with RPC supplementation (343, 343, 300, 282 nmoles/(hour \times g wet weight); $P < 0.02$). Liver content of total lipid was not affected by RPC supplementation (9.9, 10.6, 8.3, 8.2 % of wet weight; $P > 0.15$); however, liver glycogen content increased linearly as cows were fed increasing amounts of RPC (0.79, 0.81, 1.12, and 1.40 % of wet weight; $P < 0.02$). Neither prepartum (12.8, 12.0, 12.9, 12.5 kg/d) nor postpartum (18.4, 18.9, 18.3, 18.7 kg/d) dry matter intake was affected by treatment. Yield of milk (39.4, 43.5, 40.2, 41.1 kg/d) and percentages of fat (4.04, 4.22, 3.97, 4.29 %) and protein (2.98, 3.02, 3.00, 3.07 %) were not affected by treatment; however, yield of 3.5% fat-corrected milk (42.4, 47.9, 42.7, 45.6 kg/d) tended ($P < 0.12$) to be increased by RPC supplementation. These data suggest that hepatic fatty acid metabolism is sensitive to supply of choline during the periparturient period. Further research is required to determine whether choline supplementation during the periparturient period affects the rate of export of fatty acids from liver as lipoprotein triglycerides.

Key Words: Choline, Liver, Dairy Cow

1080 Splanchnic metabolism in transition dairy cows. C. K. Reynolds*, P. C. Aikman, D. J. Humphries, and D. E. Beever, *University of Reading, Reading, UK.*

Splanchnic metabolism was measured in 4 multiparous, catheterized, rumen cannulated Holstein \times Friesian cows in late gestation and early lactation. From at least 6 wk before expected calving date (CD) cows were fed a grass-silage based gestation TMR for BW (756 kg) stasis plus a maize-silage based lactation TMR at 2 kg DM/d beginning 10 d before expected CD. After calving lactation TMR incrementally replaced gestation TMR and was fed at ad libitum DMI. Cows were fed daily rations in equal meals provided at 8-h intervals. Hourly measurements (8) of splanchnic (portal-drained viscera [PDV] and liver [LIV]) blood flow (BF, L/h) and net nutrient flux (mmol/h) were obtained (on average) at 19 and 11 d before and 11, 22, 33 and 83 d after CD. For tabular data shown rates increased ($P < 0.01$) after calving. After calving splanchnic BF and oxygen use more than doubled, with much of the increase within 11 d. Net PDV absorption of nutrients (e.g. lactate)

increased more gradually, reflecting increases in DMI. This suggests factors additional to intake contribute to the regulation of splanchnic BF and oxidative metabolism in postpartum dairy cows.

Day from CD...	-19	-11	11	22	33	83	SEM
DMI, kg/d	9.7	9.8	14.1	16.9	19.4	21.8	0.9
Milk yield, kg/d	-	-	36.3	41.9	44.0	41.0	1.3
PDV BF	944	1009	1675	1620	1667	2040	153
PDV oxygen	-1504	-1452	-2390	-2494	-2911	-3900	285
PDV lactate	99	93	133	177	200	205	24
PDV BHBA	143	131	171	191	251	289	31
LIV BF	1120	1140	2099	2139	2098	2408	125
LIV oxygen	-1473	-1619	-3159	-3336	-3454	-4092	230
LIV glucose	291	314	639	760	810	845	57
LIV lactate	-92	-128	-268	-238	-229	-143	35
LIV BHBA	142	157	398	309	429	247	68

Key Words: Splanchnic, Cows, Transition

1081 Visceral tissue mass in transition dairy cows. C. K. Reynolds*, B. Durst, D. J. Humphries, B. Lupoli, A. K. Jones, R. H. Phipps, and D. E. Beever, *University of Reading, Reading, UK.*

Visceral tissue mass was measured in 36 Holstein \times Friesian cows in late gestation and early lactation. For 6 wk before expected calving date (ECD) cows were fed a grass-silage based gestation TMR for BW (671 kg) stasis plus a maize-silage based lactation TMR (2 kg DM/d) beginning 7 d before ECD. Three groups (12 cows each) received no supplement, supplemental barley (800 g/d) or supplemental rumen-protected soybean meal (750 g/d) from 6 wk before ECD until calving. Three cows from each treatment group were slaughtered at 21 and 7 d before ECD and 10 and 22 d after calving and the wet weight of visceral tissues measured. In addition, cranial sac rumen papillae were excised from a 2.54 cm^2 ventral area and digitally analyzed. At d -21, -7, 10 and 22 DMI was 11.5, 12.3, 11.6 and 16.0 (SEM 0.7) kg/d, respectively. Milk yield at d 10 and 22 was 26.6 and 31.9 (SEM 1.3) kg/d, respectively. Supplements had no effect on visceral tissue mass ($P > 0.14$). Most tabular data are mass (kg) before or after calving. There were no effects of transition on length, width or surface area of rumen papillae, but total tissue mass increased after calving. Weights of the reticulo-rumen, intestines and liver also increased, but largely on day 22 after DMI increased.

Day of study...	-21	-7	10	22	SEM	$P <$
Reticulo-rumen	12.2	11.8	12.3	14.2	0.5	0.02
Stomach	21.3	20.4	21.4	22.2	0.7	0.43
Small intestine	8.9	8.1	8.6	9.5	0.2	0.01
Large intestine	4.9	4.5	4.6	5.9	0.4	0.06
Liver	9.0	8.8	8.8	9.6	0.3	0.10
Spleen, g	1027	1050	940	836	65	0.10
Mesenteric fat	6.2	5.7	5.1	4.3	0.4	0.04
Omental fat	10.9	12.4	10.9	9.3	1.2	0.40
Papillae number/ cm^2	31	37	32	27	3	0.15
Papillae mass, g/cm^2	2.5	2.8	3.4	3.9	0.3	0.02

Key Words: Viscera, Cows, Transition

1082 Effects of high and low concentrations of UIP fed prepartum on postpartum production and health of Holstein cows during heat stress. M. L. Scott*¹ and W. B. Tucker¹, ¹*Mississippi State University, Mississippi State.*

Our objective was to evaluate the effects of feeding high or low concentrations of UIP to thermally stressed dry cows on subsequent lactational performance and health. Forty-two Holsteins were assigned to two treatments based upon expected calving date and mature equivalent milk yield. Treatments were diets containing low or high UIP (32% or 40% of diet dry matter; Trt 1 and Trt 2, respectively). Diets were fed from 3 wk prior to expected parturition until parturition. Thereafter, all cows received the same total mixed ration for 90 days postpartum.

Feed intake was measured daily throughout the study. Blood samples were collected weekly from 3 wk prepartum until 90 d postpartum. Neither daily actual milk yield (30.7 ± 3.25 and 30.9 ± 3.1 kg for Trt 1 and 2) nor daily dry matter intake (14.3 ± 1.32 and 15.4 ± 1.24 kg for Trt 1 and 2) during lactation were affected by the UIP concentration of the diet fed prepartum. However, cows fed high UIP prepartum tended to produce more milk from wk 10 to wk 13 postpartum than did cows on Trt 1. Postpartum serum calcium and blood urea nitrogen concentrations were not affected by the diet fed prepartum, although blood urea nitrogen increased throughout the postpartum period for both treatments.

Key Words: Dairy cow, Heat stress, Bypass protein

1083 Prepartum energy and protein intake of dairy cows. 1. Effect on pre- and post-parturient performance. L. Doepel^{*1}, H. Lapierre², and J.J. Kennelly¹, ¹University of Alberta, Edmonton, Canada, ²Dairy and Swine R & D Centre, Lennoxville, Canada.

Twenty-six multiparous Holstein cows were used to examine the effects of prepartum energy and protein intake on periparturient performance. Two levels of energy, 1.61 Mcal/kg NE_L (HE) and 1.27 Mcal/kg NE_L (LE), and two levels of protein, 16.3% CP (HP) and 11.1% CP (LP), were tested according to a factorial arrangement in a randomized block design. Treatments began 21 days before expected calving date. After calving, all cows were fed a single diet (1.79 Mcal/kg NE_L and 18.7% CP). Cows on the LEHP treatment had a larger drop in intake at calving than cows on the other treatments (energy by protein by period interaction, $P = 0.07$). Cows on the high energy treatments consumed less pre-calving but more post-calving than cows on the low energy diets (energy by period interaction, $P = 0.02$). Milk and milk component yields were unaffected by treatment. There were no differences between treatments for milk lactose and protein content, but for milk fat content there was a trend for an energy by protein interaction ($P = 0.09$). Body condition score during the close-up dry period increased for cows on the HEHP treatment but decreased for cows on the other treatments (energy by protein by period interaction, $P = 0.06$). During lactation cows on the HELP diet lost more body condition than the other cows. The data from this study suggest that feeding diets higher in energy and protein than that recommended by NRC may not benefit production in early lactation dairy cows.

	HEHP	HELP	LEHP	LELP	(SEM)
DMI, close-up dry, kg/d	13.2	12.2	14.1	13.0	0.86
DMI, calving, kg/d	8.8	7.2	6.7	7.8	0.90
DMI, early lactation, kg/d	17.5	16.6	15.7	15.3	0.79
BCS, precalving	2.96	3.17	3.26	3.14	0.10
BCS, calving	3.05	3.16	3.18	3.06	0.10
BCS, early lactation	2.71	2.65	2.80	2.79	0.09
Milk yield, kg/d	37.4	34.9	34.8	34.3	1.85
4% FCM, kg/d	37.2	36.8	36.7	35.7	1.95
Milk fat, %	4.01	4.44	4.45	4.33	0.15
Milk fat, kg/d	1.48	1.52	1.52	1.47	0.08
Milk protein, %	3.25	3.23	3.26	3.30	0.13
Milk protein, kg/d	1.19	1.12	1.11	1.11	0.08
Milk lactose, %	4.46	4.43	4.40	4.45	0.07
Milk lactose, kg/d	1.68	1.55	1.54	1.52	0.08

Key Words: Transition cow, Energy, Protein

1084 Effects of implanting and explanting on performance of finishing steers. B.A. Berry^{*1}, D. R. Gill, F. N. Owens, B. Freking, and B.A. Gardner, ¹Oklahoma State University, Stillwater.

Previously nonimplanted Angus x Senepol crossbred steers ($n=125$; BW 332 kg \pm 34) were randomly assigned to one of five implant schemes for a 140-d finishing trial. All treatments, with the exception of the negative controls (treatment 1), received a combination estradiol (24 mg) and trenbolone acetate (120 mg) implant on d 0. On d 84, the treatments consisted of 1) no implant administered; 2) a second combination implant; 3) removal of the initial implant and administration of a second combination implant; 4) removal of the initial implant without reimplantation; 5) no reimplantation without removal of the initial implant. Overall ADG was 20% greater ($P < .0001$) and dry matter

intake was increased ($P < .001$) for implanted steers as compared to control steers. Steers on all treatments, with the exception of treatment 5, converted feed to gain more efficiently ($P < .04$) than steers receiving no implants. Treatment 2 steers had higher ($P < .03$) daily gains and lower ($P < .0001$) feed to gain ratios than all other treatments. The two implant treatment groups carrying only one implant from d 84 to 140 (treatments 3 and 5) had similar daily gains but both treatments were significantly ($P < .03$) greater than treatment 4. Treatment 3 steers converted more efficiently ($P < .0005$) than both treatment groups that were not reimplanted (treatments 4 and 5) on d 84. These two groups of steers converted similarly ($P > .25$). As compared to nonimplanted cattle, implanted cattle yielded 28.5 kg more carcass, had lower ($P < .03$) percentages of KPH fat, and had more advanced ($P < .004$) skeletal maturity. Fat thickness, ribeye area, yield grade, marbling score, and percentage of treatment cattle grading Choice were similar between treatment groups. Control cattle yielded significantly ($P < .006$) more tender steaks, evaluated after both 7 d and 14 d aging periods, than twice implanted cattle, regardless of explant. After a 7 d aging period, treatments 2 and 3 had similar tenderness, however, treatment 2 was significantly ($P < .05$) tougher than all remaining treatments. After a 14 d aging period, treatment 2 was tougher ($P < .005$) than control and treatment 5.

Key Words: Implant, Performance, Carcass Traits

1085 Dynamics of rehydration and dehydration of Wisconsin long haul bull calves. T. E. Johnson^{*}, H. B. Perry, B. L. Miller, and M. A. Fowler, Land O'Lakes, Webster City, IA.

Weights, weight gains and fluid intake were examined in 812 bull calves purchased from Wisconsin sales barns (7 hour transit) over a 2 year period. Calves were weighed on arrival, fed CMR, electrolytes and water ad libitum. Calves were weighed 24 hours post arrival (initial trial weight) and 8 days post arrival (week 1 trial weight). Data were sorted by calf mortality and calf size. No differences ($P > .05$) were observed in weight gain or fluid intake between calves that lived and those that eventually died. There was a linear effect ($P < .0001$) in both calves that lived or died in 24 hour post arrival gain favoring heavier calves. There was a linear effect ($P < .0001$) in calves that lived in week 1 trial gain favoring lighter calves. No differences ($P > .05$) were seen in fluid consumption by calves of various sizes. These data suggest present fluid therapy on received calves is adequate and mortality can be attributed to factors other than trip dehydration. Also, heavier calves gain more weight 24 hours post arrival and lose more weight the first seven days on trial than lighter calves. Calves of all sizes are able to consume up to 20 pounds of fluid equally, within 24 hours post arrival.

1086 Stair-step compensatory growth regimen in gestating beef heifers. A. M. Encinias^{*1}, H. B. Encinias¹, A. E. Radunz¹, M. L. Bauer¹, R. B. Danielson¹, G. P. Lardy¹, and C. S. Park¹, ¹North Dakota State University, Fargo.

Our objectives were to evaluate performance of spring-calving beef heifers on a simplified stair-step compensatory growth (SSCG) regimen imposed at 90 d gestation. Twenty-four Angus and Angus-cross heifers (initial BW = 409 ± 1.9 kg) were grouped by AI date into three groups of eight ($n = 3$; 4 heifers pen⁻¹). Treatments were imposed at 90 d of gestation. Two treatments were assigned randomly to each group of heifers. Control (CON) heifers were fed 20.4 Mcal ME·d⁻¹ from d 90 to d 180 of gestation and 24.2 Mcal ME·d⁻¹ from d 180 to d 270 to achieve .45 kg·d⁻¹ maternal (minus fetus) ADG. Stair-step compensatory growth heifers were fed 13.3 Mcal ME·d⁻¹ (65% CON) from d 90 to d 180 (restriction) and 30.3 Mcal ME·d⁻¹ (122% CON) from d 180 to d 270 (realimentation). Oil sunflower seeds (44.5% EE) were included during realimentation to achieve calculated ME in SSCG heifers. Four-day averages were used to measure initial and final BW. Initial and final body conditions were visually estimated using BCS and ultrasonic scans of back (BF) and rump fat (RF) taken. During restriction, ADG of CON was greater than SSCG (.46 vs .25 \pm .09 kg; $P = .08$), though BW was not affected ($P = .44$). Mean BCS was not different ($P = .15$) between CON (5.7) and SSCG (5.1). However, BF and RF thickness was decreased ($P < .05$) in SSCG during restriction. Following realimentation, BW (571 vs 563 \pm 6.1 kg; $P = .41$) and ADG (1.19 vs 1.11 \pm .05; $P = .33$) did not differ between CON and SSCG, respectively. Body condition score ($P = .85$), BF ($P = .73$), and RF ($P = .53$) of SSCG were similar to CON. Energy efficiency (kg·Mcal ME) of CON and SSCG (.030 vs .035 \pm .006) during feeding period was not influenced ($P > .10$).

by treatment. A simplified stair-step compensatory growth regimen can be used to achieve similar final BW and performance of gestating beef heifers compared with conventional development methods.

Key Words: Beef Heifer, Stair-step Compensatory Growth, Gestation, Oil Seeds

1087 Dose response effect of prenatal trenbolone acetate treatment on thyroid hormone concentrations and growth and reproductive performance of beef cows. J. L. Stewart^{*1}, G. E. Carstens¹, R. D. Randel², and S. J. Falck¹, ¹Texas A&M University, College Station, ²Texas A&M University, Overton.

Trenbolone acetate (TBA) has been shown to reduce fasting metabolism of steers (Hunter & Vercoe, 1987), and increase maternal BW gain of pregnant cows without affecting fertility (Harting et al., 1997). Therefore, a dose-response study was conducted to determine the level of TBA needed to minimize feed inputs required to support BW gain during late gestation. Simmental cows were randomly assigned to one of four TBA treatments (n=14); 0, .4, .8, or 1.2 mg TBA/kg BW. Cows were implanted at 178±2 and again at 118±2 d prior to calving. A diet containing 65% whole corn, 20% chopped hay, 10% protein/mineral supplement and 5% molasses was limit fed individually using Calan gate feeders. Blood samples were collected at 14-day intervals and plasma analyzed for triiodothyronine (T3), thyroxine (T4) and blood urea nitrogen (BUN). Weekly analysis of plasma progesterone concentrations were used to determine ovarian cycling (> 1 ng/mL for 2 consecutive wk), and rectal palpation at 42 d postbreeding used to determine pregnancy rates. Feed intake (7.8±.06 kg/d), cow BW (563±6 kg) and BCS (4.7±.1) at calving were not affected by TBA treatment. Calf birth (43.8±.7 kg) and weaning weights (238±4 kg) were not affected by treatment, but calving difficulty scores increased (P<.01) as TBA dose increased (1.1, 1.0, 1.4 and 1.9 for 0, .4, .8 and 1.2 mg TBA/kg, respectively). Prenatal TBA treatment reduced (P<.05) the proportion of cows exhibiting estrus prior to breeding (77, 77, 38, and 57%, respectively) and reduced (P<.05) 42-d postbreeding pregnancy rates (92, 85, 69 and 36%, respectively). Plasma T3 and T4 concentrations throughout gestation were lower (P<.05) in cows implanted with 1.2 mg TBA/kg compared to controls, with cows implanted with .4 and .8 mg TBA/kg being intermediate. Plasma BUN concentrations were not affected by treatment. Prenatal TBA treatment did not alter cow or calf growth performance, but increased dystocia and reduced pregnancy rates in a dose-dependant manner.

Key Words: Trenbolone Acetate, Reproduction, Thyroid Hormones

1088 Effect of the partial substitution of corn by shop suey beans (*Vigna radiata* L) on the apparent digestibility of growing diets for sheep. R. Barajas^{*}, J.F. Obregon, A. Estrada, J.L. Velarde, and F. Caro, *Universidad Autonoma de Sinaloa*.

With the objective to determine the effect of the substitution of corn by shop suey beans (*Vigna radiata* L.) on total tract digestibility of growing diets for sheep. Four pelibuey sheep (16 kg) were used in a Cross Over experiment design, digestion trial. The diets in that consisted the treatments were: 1) Diet with 14.7% CP and 3.2 mcal DE/kg, containing (DM basis) 46% of cracked corn, 13.6% of canola meal, 24.3% of sudan grass hay, 13.4% of sugarcane molasses, 0.7% of urea and 2% of mineral premix (Control); and 2) Diet similar to Control diet but substituting 30% of cracked corn from the diet by row ground shop suey beans. The dry matter (DM) and organic matter (OM) intake were not affected (P>.06) by treatments. mean DM intake of experiment was 0.619 kg/day and represented the 3.8% of initial body weight of sheep. Fecal excretion of DM, OM, and CP were not affected (P>.10) by treatments. All tract dry matter digestion (72.2 vs 72.9%) was not affected (P>.10) by shop suey inclusion. Organic matter digestibility was similar (P>.10) between treatments (74.14 vs 74.67%). The substitution of corn by shop suey beans, increased (P=0.04) in 13% crude protein apparent digestibility (68.23 vs 77.09%). Taken 64% as true digestibility of crude protein of corn, the true digestibility value of crude protein of shop suey beans was 85%, and its value of digestible energy was close to corn DE value. It is concluded, that shop suey beans can be used a partial substitute of corn in growing diets for sheep.

Key Words: Chop suey beans, Digestibility, Sheep

1089 Jerusalem artichoke (*Helianthus tuberosus*) flour as a partial starch replacement for growing beef steers. T.C. Bramble^{*1}, G.V. Pollard¹, K.F. Wilson¹, B.S. Clyburn¹, A. Gueye¹, M.A. Johnson¹, J.M. Abdelrahim¹, C.R. Richardson¹, and A.J. Mjolsness², ¹Texas Tech University, Lubbock, ²Premium Sweetener Products, Glyndon MN.

The primary objective of this study was to determine if Jerusalem artichoke (*Helianthus tuberosus*) flour high in fructooligosaccharides (FOS) could serve as a partial starch replacement in the diet of growing beef steers. Four black crossbred steers averaging 239 kg were utilized in a 4 x 4 Latin square design. The four dietary treatments were A) basal diet; B) 10% artichoke flour; C) 15% artichoke flour; and D) 20% artichoke flour. The basal diet, 90% concentrate, contained no artichoke flour and was formulated to meet or exceed (1996 NRC) beef cattle requirements for growing/ finishing steers. The artichoke flour was obtained from a local supplier and was incorporated into the basal diet at the expense of steam-flaked corn. Soy protein isolate was varied across the four dietary treatments to make the diets isonitrogenous. Steers were housed in individual metabolism crates equipped with feeders and an automatic water system in a temperature controlled environment (20°C). Steers were fed once daily (0900) to approximately 90% ad libitum intake. Each of the four collection periods consisted of a 10-d adjustment to the diet, followed by a 5-d collection of total urine and fecal excretion. Crude protein in the feed, urine and fecal material was determined via the Kjeldahl method. The inclusion of Jerusalem artichoke flour, high in FOS, into growing beef steer diets as a partial starch replacement for steam-flaked corn did not (P > .05) alter apparent crude protein digestibility, apparent dry matter digestibility, nitrogen retention, or fecal excretion. Furthermore, it appears that Jerusalem artichoke flour can be used to replace up to 20% of the steam-flaked corn in a growing steers diet as indicated by no health or metabolic disorders throughout the experiment. In this regard it appears that Jerusalem artichoke flour, high in FOS, could be a suitable alternative feed ingredient for feedlot cattle diets.

Key Words: Fructooligosaccharides, Artichoke flour, Steers

1090 Ensiling of sludge from tuna processing plant as potential ingredient in ruminant diets: effects of different levels of sucrose. A.E. Sanjuan¹, A.A. Rodriguez^{*2}, J.M. Kubaryk¹, and A. Sanchez³, ¹Department of Marine Sciences, ²Department of Animal Science, ³Department of Chemical Engineering, University of Puerto Rico, Mayaguez Campus.

Ensiling of by-products generated from fisheries operations have been utilized as a process for the reduction of industrial wastes and the production of animal feedstuffs. However, enhance the quality of the fermentation is essential for the utilization of waste silage as ingredient in animal diets. This experiment was designed to evaluate different levels of synthetic sucrose as carbohydrate source on the fermentation characteristics of sludge from tuna processing plant (STPP). Sludge was collected from the Star-Kist Caribe, Inc., a commercial tuna fish industry plant located at Mayaguez, Puerto Rico. The sludge was inoculated with a lactic acid-producing bacterial inoculant applied at 105.78cfu/g of fresh material. Inoculated STPP was mixed with four levels of sucrose (0, 5, 10 and 15% of fresh material), placed into 1 kg capacity silos fitted with valve for gas release, and maintained at room temperature (27±2°C). Three silos per treatment were opened after five fermentation periods (0, 2, 4, 7 and 9 d) and silage was analyzed to determine changes in acidity, chemical composition, and ammonia-N. Silage without sugar additive had higher (P<0.05) pH than STPP ensiled with the carbohydrate source. However, for all sucrose levels acidity of ensiled material was similar after 9 days of fermentation. In all treatments, for the entire fermentation process organic matter, inorganic matter, and crude fat content were similar regardless of sucrose levels, but residual soluble carbohydrates were greater (P<0.05) in silage containing higher amount of sucrose (5 and 10%). Sludge without sucrose had a greater (P<0.05) ammonia-N content than silage containing the sugar. In summary, it is possible to ferment STPP with the addition of synthetic sucrose as carbohydrate source, but levels of inclusion higher than 5% did not resulted in a better fermentation. Further studies with a more available and less expensive sugar source are necessary to ensure a practical application of STPP as ingredient in animal diets.

Key Words: Silage, Organic waste, Sucrose

1091 Effect of feeding grapevine silage on apparent digestibility and performance of small ruminants. F.T. Sleiman*, N.I. Abi Aad, M.G. Uwayjan, and M.T. Farran, *American University of Beirut, Beirut, Lebanon.*

Twelve Awassi ram lambs averaging 45 kg BW were used in two trials of 4-wk each to evaluate the effect of feeding ensiled pruned grapevine branches on apparent digestibility and performance. Silage treatments consisted of 1) 100% corn silage (CS), 2) 100% ensiled pruned vine branches (EPVB), 3) 96%EPVB+4% ground yellow corn (GYC), and 4) 92% EPVB+8% GYC. In addition to ad libitum silage, each lamb received 0.7 kg concentrate (14% CP on DM basis) daily. Changes in silage temperature (average of 15.7 °C for all treatments) until 21d were not significantly different ($P > 0.05$). pH of CS treatment at 21d was significantly lower than that of EPVB treatments (4.19 Vs 4.42, $P < 0.05$). Silage DMI was not different among treatments although CS fed group had lower daily intakes (0.62 Vs 0.73 kg, $P > 0.05$). Change in BW did not differ significantly between CS and EPVB treatments (228 Vs 157g/d, $P > 0.05$). The apparent digestibility of DM, EE, CF, and CP of the CS group was significantly higher than other treatments (65.48, 66.43, 52.89, 57.59 Vs 59.85, 23.71, 44.78, 49.22%, respectively at $P < 0.05$). It was concluded that EPVB was well accepted and digested by small ruminants, and that its digestibility improved when ensiled with GYC.

Key Words: Silage, Pruned Grapevine Branches, Digestibility

1092 Lambs fed feed mixtures amended with extruded plate waste have inconsistent performance. P.M. Walker¹, T.R. Kelley¹, S.B. Brown*¹, and A.T. Jensen¹, *Illinois State University, Normal.*

Two feeding trials were conducted to evaluate the use of extruded plate waste (PW) as a feedstuff for sheep. In trial one (T1) 36 crossbred lambs were blocked by sex and randomly allotted within block to one of 18 pens. Each pen contained one ewe and one wether. Each pen of lambs was given ad libitum access for 105d to either an extruded mixture amended with PW (E1) or a traditional control diet (C1). In trial two (T2) 36 white faced wethers were randomly allotted to 18 pens and pair fed. Each pen of wethers was given ad libitum access for 64d to either a treatment diet (E2) amended with PW or a control diet (C2). The PW used in this study contained 35.3±7.1% DM, 33.3±6.7% CP, 15.9±2.6 ether extract, and 12.1±3.6% ADF. In T1, PW was mixed and extruded with soybean hulls and rolled shelled corn in a 40:55:5 ratio (wet wt. basis). The extruded mixture was supplemented with dicalcium phosphate, calcium carbonate and molasses to produce a diet containing CP (15.6±4.5), Ca (.91±.16) and P (.31±.11) percents similar to C1. On a DM basis E1 contained 23.9% PW. C1 consisted of corn, soybean meal, oats, ground hay, ground corn cobs, molasses, calcium carbonate, salt and RumensinTM containing 15.6±4.4% CP, .87±.26% Ca and .38±.07% P. In T2 PW was mixed and extruded in a 40:60 ratio (wet wt. basis) with the extruded 40:55:5 mixture used in E1 and then blended with corn, molasses, dicalcium phosphate, calcium carbonate, salt and Rumensin to produce a diet similar in CP, Ca and P to a control diet (C2) containing corn, soybean meal, soybean hulls, molasses, calcium carbonate, salt and Rumensin. E2 contained 24.1% PW on a DM basis. Mean starting and ending wts. of the lambs in T1 and T2 were 27.7±5.9kg and 55.9±4.9kg and 40.7±3.9 and 56.1±5.4kg, respectively. During T1, C1 compared to E1 lambs had higher ($P < .05$) ADG (299.6±36.3g vs. 259.0±54.5g), lower ($P < .05$) ADFI (811.1±64.0g vs. 2113.6±748.6g) and higher ($P < .05$) gain:feed (.37:1g vs. 12:1g). During T2, no significant differences between C2 and E2 lambs were observed in ADG (mean = 231.6±40.9g), ADFI (mean = 1766.1±168.0g) and gain:feed (mean = .13:1g). The data of this study suggest that plate waste can be utilized as a feedstuff but sheep fed processed food waste may have inconsistent performance compared to sheep fed traditional diets.

Key Words: Extruded, Plate Waste, Sheep

1093 Dry field peas as a component in grain starter rations for preweaned and weaned dairy calves. G.D. Marx*, *University of Minnesota, Crookston, MN.*

Performance of 34 preweaned Holstein dairy calves during a 5 week period and 32 weaned calves during a 5 week period was evaluated when

dry field peas were included at 40% of the grain starter in the experimental ration. The control ration utilized barley at 40% of the grain with the balance of both rations containing similar amounts of corn, molasses, mineral, vitamins and balanced to 18% crude protein with soybean meal. This grain starter was fed free choice to preweaned calves and to weaned calves at 1.64 kg/animal/d along with free choice alfalfa haylage. New-born calves were fed colostrum for 3 days, subsequently given 4.4 kg whole milk/d, divided between two daily feedings, until weaned at 5 weeks. Calves were housed inside an insulated and ventilated warm barn in individual steel pens 1.2 m x 1.5 m. The temperature of the calf facility was maintained at 10 °C during the winter months. Water was available free choice with automatic waterers in every pen. Feed intakes and refusals, body weights and health data were collected. Data were analyzed by GLM procedure of SAS. Average daily weight gains for the preweaned and weaned calves fed the field peas were 0.35 and 0.69 kg, and control calves were 0.35 and 0.67 kg. Daily grain starter intakes for the preweaned and weaned calves fed field peas averaged 0.55 and 1.64 kg, and control calves were 0.53 and 1.64 kg. No differences ($P > 0.05$) were noted between treatments for rate of gain or starter consumption. Forage intakes for the weaned calves and feed-to-gain ratios were similar for both treatment groups. No unusual health problems were observed. Feed intake and palatability was adequate and indicated that field peas were acceptable and a satisfactory component at 40% of grain starter rations for both preweaned and weaned dairy calves.

Key Words: Dairy calves, Calf starter, Field peas

1094 Combinations of wet corn gluten feed and steam-flaked corn in finishing cattle diets: effects of E. coli, total coliforms, VFA profiles, and pH. J. J. Sindt*, J. S. Drouillard, H. Thippareddi, R. K. Phebus, D. L. Lambert, T. B. Farran, S. P. Montgomery, H. J. LaBrune, and J. J. Higgins, *Kansas State University, Manhattan.*

Crossbred beef steers (n=615; 291 kg BW) were fed diets containing varying proportions of wet corn gluten feed (CGF) and steam flaked corn (SFC) throughout a 152-d finishing experiment. Steers were blocked by previous treatment and allocated, within block, to each of three diets (four pens per diet, 48 to 53 steers per pen). Ratios of SFC to CGF were 80:0, 60:30, and 30:60 for 0CGF, 30CGF, and 60CGF treatments, respectively. Samples of rumen fluid and feces were collected from 180 steers (three animals per pen on each sampling day) on d 114 to 118 to evaluate effects of diet on total and acid resistant *Escherichia coli* (*E. coli*) and coliforms, VFA profiles, and pH. Samples of rumen fluid and feces were incubated for 1 h in citric acid/sodium phosphate buffer solutions at pH 2, 4, and 7 for determination of total and acid resistant *E. coli* and coliforms. Samples were serially diluted, plated onto PetrifilmTM plates, incubated at 37° C for 24 to 48 h, and enumerated. A linear increase was observed for ruminal pH (6.07, 6.15, 6.23; $P < 0.01$) and fecal pH (6.78, 6.81, 6.94; $P < 0.01$) for 0CGF, 30CGF, and 60CGF, respectively. Diet did not impact ($P > 0.40$) *E. coli* or total coliform counts in ruminal fluid and fecal samples subjected to pH 2, 4, or 7 buffer treatments. Cattle fed 60CGF had higher molar proportions of fecal acetate (AC) and lower proportions of fecal propionate (PR) than cattle fed 0CGF ($P < 0.05$), but AC:PR was not different ($P > 0.17$) among treatments. The molar proportion of ruminal AC and AC:PR were greater ($P < 0.05$) and molar proportion of ruminal PR was lower ($P < 0.05$) for cattle fed CGF60 than for cattle fed CGF00. Addition of CGF to finishing diets altered VFA concentrations and increased pH; however, no differences were observed with respect to numbers of *E. coli*, total coliforms, acid resistant *E. coli*, or acid resistant coliforms.

Key Words: E. coli, Wet corn gluten feed, Finishing cattle

1095 Relationship between dry matter intake, body weight, and milk yield in dairy cows: A summary of published data. A. N. Hristov*¹, K. A. Hristova³, and W. J. Price², ¹Department of Animal and Veterinary Sci. and, ²Statistical Programs, College of Agriculture, University of Idaho, Moscow, ID 83844, ³Moscow High School, Moscow, ID 83843.

An attempt was made to determine the relationship of dry matter intake (DMI) and body weight (BW) with milk yield (MY) in dairy cows using data from nutritional studies published in Journal of Dairy Science (volumes 1 through 82). Only articles containing feed intake and milk yield data were considered for this study. In cases where data were reported

as individual treatments within a trial, a separate observation was entered for each treatment. Where feed DM was not published, dietary DMI was determined based on tabular data (Nutrient Requirements of Dairy Cattle, NRC 1989). To remove extreme or unusual values the lower and upper 1% of the data was trimmed resulting in 5,814 and 2,752 observations for DMI/MY and BW, respectively. The bulk of the data (89%) were within the range of 14.1 to 26.6 kg/d, 15.9 to 40.5 kg/d, and 505 to 716 kg for DMI, MY, and BW, respectively. A plot of MY vs DMI indicated an approximately increasing linear relationship ($r = 0.68$). Estimation of a simple linear regression model for this data, however, resulted in moderately strong fit: $MY = -1.022 + 1.378 DMI$ ($R^2 = 0.472$; $P < 0.001$). Attempts to account for differences in BW in this relationship through a multiple regression model did not provide a better alternative ($R^2 = 0.475$). While these results suggest that DMI alone or in combination with BW cannot be used to predict MY, the data sets considered in this analysis may indicate some potential for defining a relationship. This could be accomplished by accounting for external sources of variability such as nutritional and genetic factors and differences in trial designs.

Key Words: Dairy Cows, Dry Matter Intake, Milk Yield

1096 A dynamic mechanistic model of methanogenesis in the lactating dairy cow. J.A.N. Mills^{*1}, J. Dijkstra², and J. France¹, ¹The University of Reading, Reading, United Kingdom, ²Wageningen University, Wageningen, Netherlands.

Dietary intervention to reduce methane emissions from lactating dairy cattle is both environmentally and nutritionally desirable due to the importance of methane as a causative agent in global warming and as a significant loss of feed energy. This investigation involved the modification of a dynamic mechanistic model of whole rumen function (Dijkstra et al., 1992) and the incorporation of a post-ruminal digestive element. Regression analysis showed good agreement between observed and predicted results for experimental data taken from the literature (r^2 0.76, root MSPE 15.4%). Evaluation of model predictions for experimental observations from five calorimetry studies with lactating dairy cows at CEDAR (Centre for Dairy Research, UK) showed an under-prediction (2.1MJ/d) of methane production (r^2 0.46, root MSPE 12.4%). Model development to account for discontinuous feed inputs and a physical dietary description may further improve predictions of methanogenesis. Improvements to the representation of lipid metabolism in the rumen are needed to further enhance model predictions especially for diets with supplemental fat. Application of the model to develop diets to minimise methanogenesis indicates a need to limit the concentration of soluble sugars in the concentrate. The model simulated an increase in diet metabolisability (ME/GE) of 3.5% and a 1.1% reduction in the proportion of GE lost as methane as starch replaced soluble sugars in the concentrate. On a herd basis, the model predicts that increasing dietary energy intake per cow can minimise the annual loss of feed energy through methane production. Substitution of grass silage with maize silage or concentrates may significantly reduce the environmental impact of dairy farming through methane pollution whilst increasing the dietary energy available to the dairy cow.

Reference

Dijkstra, J., Neal, H.D.St.C., Beever, D.E., France, J., 1992. Simulation of nutrient digestion, absorption and outflow in the rumen: model description. *J. Nutr.* 122, 2239-2256

Key Words: methane, model, dairy cow

1097 Evaluation of two different equations for the prediction of the energy content of Canadian grown forages. A. Fournier^{*1}, G. Allard¹, J.F. Bernier¹, H. Lapierre², and D. Pellerin¹, ¹Departement des sciences animales, Universite Laval, ²Dairy and Swine R & D Center, Agriculture and Agri-Food Canada.

Climatic conditions vary from the East to the West coast of Canada. These various conditions have a strong influence on the digestibility of forages harvested in the different longitudes. In a data set including 139 observations of chemical composition of Canadian grown forages and their digestibility in cattle, we observed that, on average, the lignin content of legume and grass forages was about one point higher in forages grown in West (dry climate) compare to East (wet climate). We used this data set to derive a prediction equation including an area factor: $DE = 3.56 - 0.029ADF\% + 0.004NDF\% - 0.067 AREA$ [West (1) or East (0)] ($n = 139$; $r^2 = 0.43$).

Twenty-two Canadian experiments done with dairy cows were used to compare this equation with the multicomponent Ohio state equation ($TDN = .93 CP + 2.25 FA + .98 (100 - NDF_N - CP - ash - FA - 1) + .75 (NDF_N - lignin) [1 - (lignin/NDF_N)^{.667}] - 7$). Experiments selected for the comparison had to include adequate data on the composition of forages (CP, ADF and NDF), concentrate feed composition, milk production and composition, body weight and body weight change. Lignin, ash and FA content of forages in these experiments were estimated with equations produced with our initial data set (lignin = $-3.82 + 0.36ADF - 0.09NDF + 0.015 (\% \text{ legume}) + 1.26AREA$ [$r^2 = 0.85$]; ash = $10.53 - 0.098NDF + 0.23PB$ [$r^2 = 0.70$]; FA = $6.089 - 0.11ADF + 0.04PB - 1$ [$r^2 = 0.54$]) when this information was not reported. Energy values of forages were predicted using the respective equation while the NRC (1989) tables were used to evaluate energy values of concentrates. The regression of NEL values based on requirements (Y) against the NEL values based on feed composition (X) were: for the Canadian equation, $Y = -0.12 + 1.02X$ ($r^2 = 0.45$; $p < 0.01$); for the Ohio state equation, $Y = -0.08 + 1.01X$ ($r^2 = 0.47$; $P < 0.01$). The slopes were not different from 1 ($P < 0.05$), and the intercepts were not different from 0 ($P < 0.05$). The feed value for NEL were overestimated by 6 and 4 % by the Canadian and the Ohio state equation, respectively.

We conclude that both equations can be used to predict the energy value of Canadian grown forages based on their chemical composition. However, both model explained only 45 % of the variation of the energy requirements.

Key Words: Digestible Energy, Forage, Equation and Prediction

1098 Growth and starch digestion by *Entodinium exiguum* as influenced by the source of starch and the presence of living rumen bacteria. M. Fondevila^{*1} and B.A. Dehority², ¹University of Zaragoza, Zaragoza, Spain, ²Ohio State University, Wooster.

In vitro growth and amylolytic capability of the rumen protozoa *Entodinium exiguum* was studied using two different sources of starch, either in the presence or absence of rumen bacteria. *E. exiguum* was obtained from sheep rumen contents and maintained in basal medium M (Dehority, 1998. *J. Anim. Sci.*, 76:1189-1196). Tubes with basal medium plus (per 100 ml) 6 ml of a 1% phosphate buffer and 0.1 g trypticase, were added with 0.35 g of either corn (C) or rice (R) starch (average particle size of 13.5 and 5.2 μm , respectively) just prior to inoculation. Treatments, for either C or R media, were: protozoa and bacteria (PB), protozoa plus 2000 U penicillin and 130 U streptomycin/ml medium (PA) and only bacteria (LB). Inoculum for PA was pre-incubated 4h with antibiotics and inoculum LB was filtered through a 5 μm membrane filter. Protozoal concentrations and starch digestion were measured in samples taken from duplicate tubes at 6, 12, 24, 36 and 48h. Protozoal growth was higher in R with PB than PA at both 24 h ($P < 0.10$) and 48h ($P < 0.05$). Generation times after 24h were slower with PB than PA both in R (28.1 vs. 15.0h) and in C (22.0 vs. 17.6h). After 36 and 48h, generation times tended to be faster in C than in R ($P < 0.10$), probably because of substrate depletion in R. Starch digestion started earlier with R ($P < 0.05$ up to 24h), but was complete for both starches with PB after 24h. Digestion with PB was numerically higher than the sum of PA and LB up to 12h with R and up to 24h with C, indicating a synergism between protozoa and bacteria in coculture. Digestion of R with LB started later than with PA (0 vs. 10% at 6h); however, digestion by LB had reached 93% after 24h, compared to only 75% with PA at 48h. When C was the substrate, the digestion pattern was very similar with PA and LB (13 vs. 8% at 24h). The total extent of starch digestion with protozoa was similar between the two starch sources; however, bacteria digest rice starch faster and to a greater extent than corn starch.

Key Words: rumen Protozoa, Starch digestion, In vitro culture

1099 Effect of increasing levels of pure corn starch in the diet of lactating dairy cows on ruminal pH. K. M. Krause^{*1}, D. K. Combs¹, and K. A. Beauchemin², ¹University of Wisconsin-Madison, Madison, WI, ²Agriculture and Agri-Food Canada, Lethbridge, AB.

The objective of this study was to investigate the effects of a linear increase in the fraction of dietary starch provided as pure corn starch on ruminal pH at a constant level of dietary NDF. Eight ruminally cannulated, multiparous Holstein cows were used in two 4×4 Latin squares

with 23-d periods. The four dietary treatments consisted of increasing levels of pure corn starch. Dried, cracked corn grain was replaced with increasing levels of pure corn starch in a manner such that total corn starch provided was kept constant at 27% of dietary DM. Corn gluten feed was used to balance the diets for equal levels of NDF (28% of DM). Diets were fed as TMRs for ad libitum intake and consisted of 40% coarsely chopped alfalfa silage and 60% concentrate (DM basis). Treatments were: 0% (ST0), 6% (ST1), 12% (ST2) and 18% (ST3) pure corn starch in the TMR (DM basis). Cows averaged 53±16 DIM at the beginning of the experiment. Daily intake of pure corn starch was 0, 1.6, 3.2 and 4.8 kg for diets ST0, ST1, ST2 and ST3, respectively. None of the measured variables were affected significantly by diet. Milk yield was 38.90±4.87 kg/d and DMI 27.12±3.50 kg/d when averaged across diets. Milk contained 3.39±0.52% fat and 3.17±0.18% protein. Cows spent 447±51 min/d ruminating and 317±56 min/d eating. Ruminal pH was measured continuously each minute for 3 days using indwelling electrodes. Mean ruminal pH and area below pH 5.8 was not affected by diet and was 5.98, 5.97, 6.01 and 5.93 and 154, 151, 176, and 207 min × pH/d for ST0, ST1, ST2, and ST3, respectively. No relationship was found between increasing fractions of dietary starch provided as pure corn starch and ruminal pH in lactating cows fed TMRs containing adequate levels of fiber.

Key Words: Corn starch, Ruminal pH

1100 Effect of subacute ruminal acidosis on the preference of cows for pellets containing sodium bicarbonate. J. L. Cumbley¹, J. C. Plaizier¹, I. Kyriazakis², J.E. Keunen¹, and B.W. McBride¹, ¹Department of Animal and Poultry Science, University of Guelph, Ontario, Canada, ²Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.

Using a previously developed nutritional model to induce sub-acute ruminal acidosis (SARA), it was determined if SARA affects the cows preference for pellets containing 4 % sodium bicarbonate compared to control pellets. Pellets also contained wheat shorts (38 %), alfalfa (38 %), beet pulp (10 %) and soy hulls (10 %) In the first experiment NaCl was added to the control pellets to balance for sodium. The control pellets of the second experiment did not contain NaCl. Four rumen cannulated Holstein dairy cows of second and third parity, in late lactation, were used. The first experiment lasted three weeks. Two SARA weeks were separated by a control week. The second experiment consisted of one SARA week followed by one control week. Ruminal pH was continuously monitored via indwelling pH probes. Cows could choose between two pellets, twice daily, for a 15 min. period (11-11:15 a.m., 3-3:15 p.m.) from Monday to Friday of each week. The pellets were offered in equal amounts (5 kg) and were offered to the animals in identical feed trays. Position of the feed was randomized per cow. Preference ratios (PR) for bicarbonate pellets were calculated after each choice period as: amount of bicarbonate pellets consumed/ (amount of bicarbonate pellets consumed + amount of control pellets consumed). In experiment 1 cows consumed predominantly bicarbonate pellets, but this was due to an aversion to the NaCl in the control pellets, as in the second experiment cows consumed predominantly control pellets. The SARA model reduced ruminal pH in experiment 1. In experiment 2, low ruminal pH was observed in the SARA week and in the control week. SARA did not affect the cows preference for the bicarbonate containing pellets in experiment 1.

Item	Exp. 1			Exp. 2		
	SARA Weeks	Control Week	P	SARA Week	Control Week	P
PR bicarbonate	0.83	0.85	n.s.	0.30	0.39	n.s.
Avg. pH	5.86	6.11	n.s.	5.85	5.93	n.s.
Time < pH 6 (min/d)	930	548	<0.05	796	830	n.s.
Area < pH 6 (min * pH/d)	337	184	<0.05	313	285	n.s.
Time < pH 5.6 (min/d)	348	194	<0.05	389	304	n.s.
Area < pH 5.6 (min * pH/d)	85	31	<0.05	78	59	n.s.

Key Words: acidosis, diet selection, dairy cows

1101 Quantification of the effectiveness of whole linted cottonseed as a forage substitute when fed with corn differing in ruminal starch availability. D.I. Harvatine*, J.E. Winkler, J.L. Firkins, and M.L. Eastridge, *The Ohio State University, Columbus, OH.*

Six ruminally and duodenally cannulated primiparous Holstein cows (517 kg) in mid-lactation were used in a 6 x 6 Latin Square with 3-wk periods. Alfalfa silage in TMR was replaced with WCS on an NDF basis to achieve six treatments with ground (G) or steam-flaked (SF) corn: forage control with G [FCG] (21% forage NDF (fNDF)); low (5%) WCS with G [LG] or SF [LSF] (18% fNDF); medium (10%) WCS with G [MG] or SF [MSF] (15% fNDF); and high (15%) WCS with G [HG] (12% fNDF). Diets were balanced for equivalent nutrient concentrations. DMI increased quadratically (P<0.05) with increasing substitution of alfalfa silage NDF with NDF from WCS (17.8, 20.0, 20.5, 20.3 kg for FCG, LG, MG and HG, respectively). Milk production did not differ across treatments (P>0.10), although milk fat % was affected quadratically (P<0.05) and milk protein % increased linearly (P<0.01) with increasing substitution with WCS (26.5, 26.6, 27.9, 27.3 kg milk; 3.45, 3.70, 3.58, 3.41% fat; and 3.04, 3.16, 3.14, 3.26% protein for FCG, LG, MG and HG, respectively). Ruminal pH and acetate:propionate (A:P) decreased linearly (P<0.01) with increasing WCS level (pH = 6.28, 6.13, 6.12, 5.93 and A:P = 3.98, 3.59, 3.21, 3.01 for FCG, LG, MG and HG, respectively). Total chewing activity time did not differ across diets (P>0.10) (785, 799, 734, 805 min/d for FCG, LG, MG and HG, respectively). However, chewing efficiency increased quadratically (P<0.05) with increasing WCS addition (209, 227, 240, 324 min/kg fNDF for FCG, LG, MG and HG, respectively). Ruminal mat consistency did not differ across diets (P>0.10). No interactions between corn source and WCS were detected (P>0.10); WCS is equally effective in lactating dairy cattle diets that contain moderate or high ruminal starch digestibility. WCS is as effective as NDF from alfalfa silage in maintaining chewing activity, milk fat %, and ruminal mat consistency in diets with at least 12% fNDF.

Key Words: Effective NDF, Non-forage fiber, Whole cottonseed

1102 Effects of speciality corn hybrids on the rumen fermentation and total tract digestion in dairy cows. V. Akay* and J. A. Jackson, *University of Kentucky, Lexington.*

Six cannulated primiparous Holstein cows were fed three diets in a 3 x 6 Latin rectangle design with 28 d periods to determine the effects of speciality corn hybrids on rumen fermentation and digestion. Diets were: 1) control (normal corn), 2) nutridense corn (high oil and protein), and 3) waxy corn (high amylopectin) diets. Diets contained 11% alfalfa silage, 33% corn silage (normal, nutridense and waxy corn silage), 28% cracked corn grain (normal, nutridense and waxy corn grain), and 28% other ingredients (DM basis). Cows were dosed with chromic oxide twice daily (20g/d) the last 11 d of each period. Fecal grab samples were collected every 12 h during the last 6 d of each period; collection times were postponed 2 h daily. Ruminal samples were collected every 6 h during the last 6 d of each period; the sampling time was adjusted ahead 1 h daily. Data were analyzed using GLM (for digestibility) and Proc Mixed Procedure (for ruminal parameters) of SAS. Differences were considered significant at P < 0.05. Ruminal pH (5.90, 5.83 and 5.84, respectively) was lower for nutridense and waxy corn diets than normal corn diet, and ruminal NH₃-N concentration (9.62, 11.1 and 8.87 mg/dl, respectively) was higher for nutridense corn diet than normal and waxy corn diets. Ruminal acetate concentration (59.3, 58.2 and 57.2 mol/100 mol, respectively) was highest for normal corn diet and lowest for waxy corn diet. Ruminal propionate concentration (21.1, 22.2 and 23.3 mol/100 mol, respectively), however, was higher for waxy corn diet than normal corn diet. Total VFA concentration (150.8, 156.1 and 155.9 mM, respectively) tended to be higher for nutridense and waxy corn diets than normal corn diet. Apparent DM, OM, ADF, NDF and gross energy digestibilities were similar among diets. Apparent starch digestibility (83.4, 82.0 and 88.6%, respectively) was higher for waxy corn diet than nutridense corn diet; however, CP digestibility (58.5, 59.8 and 58.2%, respectively) tended to be higher for nutridense corn diet than waxy corn diet. The results suggest that animals consuming waxy corn hybrid as silage and grain could benefit from higher starch digestibility and more efficient rumen NH₃-N utilization.

Key Words: Speciality corn hybrids, Ruminal fermentation, Apparent digestibility

1103 Effects of dietary carbohydrate source, propionate, and fat on performance of lactating dairy cows during heat stress. J. Jennings*, A. Akinyode, M. Hall, and C. Staples, *University of Florida, Gainesville.*

The objective was to evaluate the effects of nonstructural carbohydrate (NSC) sources, fat and propionate on animal response to heat stress. Eight ruminally cannulated, multiparous cows in midlactation were assigned to one of eight dietary treatments arranged in a 2 by 2 by 2 factorial incomplete Latin square design with three 21-d periods. Samples were collected during the last 7 d of each period. Main effects were two sources of NSC (citrus pulp or hominy fed at 27 and 25% of dietary DM, respectively), calcium salts of long chain fatty acids (fat; Megalac[®]) fed at 0 or 0.73% of dietary DM, and propionate (Prop: Nutrocal[®]) fed at 0 or 0.6% of dietary DM. Ruminal pH was measured hourly for 7 h after feeding. Body temperature and respiration rates were measured on 3 d at 0500 and 1700 h. Values are least square means \pm standard error with significance declared at $P < 0.05$. Daily DM intake (18.1 ± 0.9 kg), milk yield (21.0 ± 2.1 kg) and milk fat % ($3.58 \pm 0.24\%$) were similar across diets. Milk protein % was greater for cows fed hominy (3.13%) vs citrus (3.06%) or fat (3.17 vs $3.02\% \pm 0.04$). Yield of milk fat (0.78 vs 0.69 kg/d) and protein (0.68 vs 0.60 kg/d ± 0.04) were greater for cows fed fat. Prop increased yield of fat corrected milk when cows were fed citrus pulp (20.5 vs 17.1 kg/d), but reduced production when fed hominy (18.3 vs 21.2 kg/d ± 1.1); energy source by propionate interaction). Cows fed fat had a greater concentration of milk urea nitrogen when fed hominy (16.8 vs 13.7 mg/dl), but a lower concentration when fed citrus pulp (17.1 vs 16.0 mg/dl ± 1.0). Prop elevated mean ruminal pH of cows fed fat (6.16 vs 5.92), whereas Prop decreased the mean pH in cows not fed fat (6.02 vs 6.09 ± 0.09). Feeding fat with citrus pulp reduced afternoon body temperature (39.3 vs 39.6° C), whereas fat had no influence on body temperature of cows fed hominy (39.5 vs 39.5° C ± 0.01). Dietary fat, propionate, and NSC sources interacted to affect animal responses during heat stress.

Key Words: heat stress, NSC, dairy cows

1104 Creating a nutritional model to induce Subacute Ruminant Acidosis (SARA) in the dairy cow. J.E. Keunen¹, J.C. Plaizier^{*1}, I. Kyriazakis², T. Duffield³, and B.W. McBride¹, ¹*Department of Animal and Poultry Science, University of Guelph, Ontario, Canada*, ²*Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.*, ³*Department of Population Medicine, Ontario Veterinary College, University of Guelph, Canada.*

The effects of two nutritional models to reduce rumen pH in mid to late lactation dairy cows were investigated. The aim of these models was to enable studies on SARA with these cows. Rumen pH was measured continuously via in-dwelling probes. In the first model, using 4 cows in a Latin square design, high moisture corn (HMC) replaced 0, 20, 25, and 30% of the dry matter (DM) in a total mixed ration (TMR). Cows were fed for 5 consecutive days, 2kg TMR at 7 am, HMC at 9 am, and TMR was re-introduced at 1 pm, followed by a 9-day rest period. Average pH, time and area with pH below 6.0 and 5.6 were calculated daily for each cow. Time below pH 6 and 5.6 for the control (0%) was 169.95 and 36.55 min, respectively, across all periods. Average time below 6 and 5.6 for the 20, 25, and 30% levels was 361.65 and 73.48 min, as these treatments did not differ significantly from each other. In the second model, another 4 cows were used. 25% of the ad libitum DM intake of the TMR was replaced with grain pellets (50% wheat/50% barley). Pellets were fed at 9 am (15%) and 1 pm (10%) for a 5-day period, followed by a 9-day rest period, and was repeated twice. Restricted TMR was offered at 7am, 11-11:30 am, and 3-3:30 pm. Using this grain model, pH averaged 0.14 units lower during challenge weeks than during control weeks. Time below pH 6.0 averaged 318.49 and 640.78 min. for the control weeks and the challenge weeks, respectively. Times below pH 5.6 were on average 117.63 and 109.15 min. for control and challenge weeks, respectively. These data indicate that the cows in the first model did not experience a lengthy enough period of decreased rumen pH to induce SARA. In contrast, cows in the second model had a significant time period below pH 6 and 5.6, between 12 pm and 8 pm, indicating successful induction of SARA, similar to that observed in transition dairy cows during the first week post-calving.

Key Words: acidosis, dairy cow, model

1105 Diet selection to attenuate decreased rumen pH in the dairy cow. J.E. Keunen^{*1}, J.C. Plaizier¹, I. Kyriazakis², T.M. Widowski¹, and B.W. McBride¹, ¹*Department of Animal and Poultry Science, University of Guelph, Ontario, Canada*, ²*Animal Biology Division, Scottish Agricultural College, Edinburgh, U.K.*

Using a previously developed nutritional model to induce prolonged periods of decreased rumen pH, it was addressed whether changes in rumen pH affected the feed preference for alfalfa hay compared to alfalfa pellets. Four multi-parous rumen cannulated Holstein dairy cows, mid-late lactation, were used in this trial. The trial took place over three weeks. Two grain challenge weeks, developed in a previous experiment, that lead to decreased rumen pH were separated by a control week. Rumen pH was continuously monitored via in-dwelling probes. Cows were given choice of 2 feeds, 2x daily, for a 30 min. period (11-11:30 am, 3-3:30 pm). The feeds offered, during the choice periods, alfalfa hay and alfalfa pellets, were similar in chemical composition but different in particle size. These feeds were offered in equal amounts (3 kg) to the animals in identical feed trays. Position of the feed was randomized per cow prior to the trial. Preference ratios (PR = Amount of Hay Consumed/ (Amount of Hay Consumed + Amount of Pellets Consumed) for alfalfa hay were calculated after each choice period. During the first day of each choice period, the PR for alfalfa hay was lower than during the last 4 days of those weeks due to sampling behaviour of the animals. During subsequent days of the grain challenge weeks, cows had a strong preference for alfalfa hay. There was no difference in diet selection between the two periods within a day. This preference was reduced during the control week. Time and area below pH 6 and 5.6 was significantly greater in the grain weeks than in the control week. Hence, the lower rumen pH observed during the grain weeks was associated with an increased preference for alfalfa hay compared to alfalfa pellets.

Item	Grain Weeks	Control Week	P
PR Hay	0.85	0.60	< 0.05
Avg. pH	5.93	6.19	< 0.05
Time < pH 6 (min/d)	831	273	< 0.001
Area < pH 6 (min*pH/d)	263	64	< 0.01
Time < pH 5.6 (min/d)	264	56	< 0.05
Area < pH 5.6 (min*pH/d)	49	10	n.s.

Days 2-5 of each week

Key Words: acidosis, dairy cow, diet choice

1106 Effects of concentrate level and feeding management on feeding behavior and saliva production by lactating dairy cows. M. Maekawa^{*1}, K.B. Beauchemin², and D.A. Christensen¹, ¹*University of Saskatchewan, Saskatoon, Canada*, ²*Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

The objectives of this study were to determine the effects of 1) proportion of concentrate "40, 50, 60%, DM basis" in the diet, and 2) feeding a TMR compared to separate ingredients "SI" for a diet containing 50% concentrate, on feeding behavior and saliva production. Eight ruminally cannulated lactating Holstein cows were used in a double 4 x 4 Latin square. Chewing time was measured visually, while saliva secretion during eating and resting was estimated by collecting swallowed saliva at the cardia. Cows were fed for ad libitum intake but DMI "18.2 \pm 0.6 kg/d" was similar for all diets. Level of concentrate in the TMR had no effect on eating time, but cows fed a TMR spent more time eating than cows fed SI "241 vs. 198 min/d; $P < 0.05$ ". Rumination time decreased "P = 0.12" from 584, to 516, and 498 min/d as proportion of concentrate in the diet increased from 40, to 50, and 60%, respectively. Cows fed SI tended to ruminate more than cows fed a TMR "584 vs. 516 min/d; P = 0.12". Salivation rate during eating "115 \pm 8 ml/min" was not affected by proportion of concentrate in the TMR, but for cows fed SI, salivation rate was higher for concentrates than forage "201 vs. 94 ml/min; P < 0.05". Estimates of the total amount of saliva secreted during eating tended to be lower for cows fed SI versus a TMR "23.5 vs. 28.6 L/d; P = 0.12", but there were no effects of proportion of concentrate in the TMR. Estimates of the total amount of saliva secreted during resting were similar for all diets "66.5 \pm 8 L/d". Results indicate that feeding a TMR rather than SI increases time spent eating and the amount of saliva secreted during eating, although this benefit may be negated by reduced rumination time. Feeding a TMR may be particularly beneficial when proportion of concentrate in the diet is high, as eating time and salivation rate were similar to that of a high forage diet.

Key Words: Dairy cow, Chewing activity, Saliva production

1107 Effect of feeding corn meal or steam-rolled corn to lactating Holstein cows on total tract digestion, feeding behavior, milk yield and milk composition. K. C. Uchida^{*1}, C. J. Sniffen², C. S. Ballard², P. Mandebvu², and M. P. Carter², ¹Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan., ²W. H. Miner Agricultural Research Institute, Chazy, NY.

Sixty-six lactating multiparous Holstein cows (113546 days in milk) housed in a free-stall facility at Miner Institute in northeastern New York were blocked and randomly assigned to one of 3 dietary treatments containing on DM basis: 17% corn meal (CM); 17% CM and steam-rolled corn (SRC) mixed in a ratio of 1:1 (CMSRC); or 17% SRC. Diets were fed as total mixed rations (TMR) and were formulated using the CPM Dairy[®] model. The density (g/L) of CM and SRC respectively were: 635 and 553. The first 2 wk of the 8 wk-study were an adjustment period and data collected during this period were used as covariate in the statistical analysis of data collected in wk 6-8. Cows were fed test diets from wk 3-8. During wk 7 and 8, nutrient digestion by cows was determined using Cr₂O₃ as an indigestible marker. The nutrient composition (%DM) of the CM, CMSRC, and SRC based TMRs, respectively were OM: 93.6, 92.4, 92.3; starch: 24.3, 23.9, 23.8; CP: 18.5, 18.6, 18.6; and NDF: 34.5, 34.5, 34.6. Apparent total tract digestibilities (%) of nutrients by cows fed CM, CMSRC, and SRC based TMRs, respectively were DM: 62.4, 63.5, 60.3 (SE=1.84); OM: 64.0, 64.7, 61.1 (SE=2.04); CP: 67.9, 68.4, 65.5 (SE=1.94); starch: 93.9, 96.5, 94.6 (SE=1.27); and NDF: 46.9, 46.8, 43.0 (SE=2.51). Data collected during wk 6-8 from cows fed CM, CMSRC, and SRC based TMR, respectively were time spent ruminating (min/d): 346, 438, 374 (SE=18.9); body condition score: 2.87, 2.95, 2.99 (SE=0.025); milk yield (kg/d): 39.5, 39.2, 39.6 (SE=0.35); 3.5% FCM yield (kg/d): 41.7, 40.9, 39.7 (SE=0.52); milk fat (%): 3.79, 3.81, 3.71 (SE=0.07); milk CP (%): 3.21, 3.23, 3.22 (SE=0.013); and milk lactose (%): 4.87, 4.90, 4.88 (SE=0.011). Cows fed TMRs containing SRC had better body condition ($P=0.003$) and ruminated longer ($P=0.032$). However feeding CM and SRC together did not significantly improve digestion of DM, OM, CP, starch or NDF, yield of milk and milk components. In conclusion feeding SRC mixed with CM improved the animal body condition and rumination when compared with CM. Partial or complete substitution of CM by SRC in diets for lactating dairy cows did not improve DM and nutrient digestion, milk yield, and milk composition.

Key Words: Key words: Dairy cow, Steam-rolled corn, Digestion, Milk yield, Feeding behavior

1108 The effect of starch retrogradation on the nutritive value of corn hybrids. K. F. Wilson^{*1}, C. R. Richardson¹, and S. D. Soderlund², ¹Texas Tech University, Lubbock, ²Optimum Quality Grains, West Des Moines IA.

Ten commercially grown hybrids were used to determine the effects of starch retrogradation on the availability of crude protein, crude fat, fiber, total starch, enzyme susceptible starch (ESS); extent of dry matter disappearance; and presence of free moles of sulfhydryls (FMS). Each hybrid was evaluated in ground, steam-flaked (SF), and retrograded (RET) forms. Retrogradation was achieved by air drying each steam-flaked hybrid and then waiting 24 h before analysis. Pairs of samples of steamflaked and retrograded were compared to determine relative differences in the variables examined. Differences were ($P<.05$) observed for individual hybrids across the treatments, and within hybrids across the ground, steam-flaked, and retrograded forms. Steam-flaking and retrogradation improved ($P<.05$) crude protein, starch availability, and free moles of sulfhydryls. However, steam-flaking and retrogradation resulted in lower crude fat values across the hybrids. Differences ($P<.05$) were also found for the dry matter disappearance. These data indicate a significant interaction of hybrid and processing treatment in all variables except ADF, 4 h dry matter disappearance, 8 h dry matter disappearance, and 24 h dry matter disappearance.

Form	Hyb ID									
	A	B	C	D	E	F	G	H	I	J
ESS										
SF	73.3	86.0	85.3	85.4	93.6	94.0	86.1	79.0	84.9	88.1
RET	86.8	79.2	83.1	74.7	85.1	81.3	75.0	78.2	79.6	80.0
FMS										
SF	.40	.35	.47	.31	.39	.43	.34	.37	.38	.41
RET	.29	.30	.32	.29	.35	.33	.30	.37	.31	.32

Key Words: Steamflaking, Corn hybrids, Nutrient composition

1109 Comparing tempered and dry-rolled barley with and without the inclusion of yeast culture supplements in total mixed diets of early lactating dairy cows. J.W. Schroeder, M.S. Laubach*, D.B. Carlson, D.E. Schimek, W.L. Keller, and C.S. Park, North Dakota State University, Fargo, ND USA.

Objectives were to determine if tempered barley in combination with both a live yeast culture and a fungal extract preparation enhances the utilization of barley and alters the yield or composition of milk. Barley use promotes more rapid fermentation and lower ruminal pH. Tempering improves apparent dietary digestibility, while adding certain yeast cultures reduces lactic acid production and(or) improves nutrient utilization of forages in ruminants. Barley was tempered for 24 h at 20% moisture and rolled before adding to completely blended diets. Twenty-four primiparous and multiparous Holstein cows averaging 575 kg body weight and 46 d in lactation were stratified by age, days in milk, milk yield, and randomly assigned to one of four isonitrogenous, isocaloric barley-based diets: 1) tempered rolled barley (TRB-W); and 2) dry-rolled barley (DRB-W) with additives (a yeast culture and a source of fibrolytic enzyme, 9 and 15 g/d per cow, respectively); 3) tempered rolled barley (TRB-O); and 4) dry-rolled barley (DRB-O) without additives. Cows were fed the respective diets in Calan gates for nine wk. A univariate analysis was conducted for a fixed model blocked for variation due to feeding period. Substituting tempered for dry-rolled barley did not alter milk yield, dry matter intake (DMI), or body condition. Cows fed TRB-O had greater ($P < 0.01$) concentrations of milk protein, lactose, solids-non-fat, and casein than DRB-O. Additives tended to diminish differences in milk components of cows fed tempered or dry-rolled barley, but did not affect fat-corrected milk yield or body condition. Milk urea nitrogen (MUN) levels were greatest ($P < 0.01$) for cows on the DRB-O diet. Collectively, tempering and the addition of yeast and enzyme supplements lowered rumen ammonia ($P < 0.001$) and subsequent MUN ($P < 0.001$). Cows fed TRB-W had the lowest DMI, but no differences existed among treatments for corrected milk yield. Yeast and enzyme additives increased ($P < 0.02$) both energy and protein efficiency, especially when used in combination with barley that was tempered versus dry-rolled prior to feeding.

Key Words: Barley, Dairy cattle, Tempered, Dry-rolled, Yeast supplements, Enzyme additives

1110 Ruminal digestion of alfalfa hay and alfalfa hay:wheat straw mixtures by llamas (*Lama glama*). M. S. Morales*, R. Cabrera, A. Lopez, C. Navia, H. Salazar, and A. Fuentes, Universidad de Chile.

Ruminal utilization of alfalfa hay (AH) (100%, T1), AH : wheat straw (WS) (50:50, T2), and AH:WS (75:25, T3) was measured in 3 llamas with ruminal cannula in a 3x3 latin square; sampling was replicated on d 14 and 18 of each 21 d period. Feeds were ground to 2.5 cm particle size and llamas were limit fed once daily from 8 to 10 AM. AH and WS contained 43.5 and 70.5% NDF and 19.1 and 4.0% CP, resp. DM intakes by treatment were 0.78, 0.79 and 0.63 kg/d (<1% of BW). DM degradability (DMD) was measured in sacco at 0, 2, 4, 8, 12 and 24 hr. At the same times (except 24 hr) ruminal liquid was sampled for pH and VFA concentration. 24 hr DMD in sacco was 76.1±1.69 (mean±SD), 62.8±3.08 and 56.0±5.26% for T1, T2 and T3, resp. DMD was assessed by Orskov and MacDonald (J. Agric. Sci. Camb. 92:499, 1979), using a ruminal turnover rate for DM of 2.9% hr⁻¹; a, b and c parameters of the DMD curve were 31.1, 48.6 and 0.14; 22.5, 46.3 and 0.09 and 19.1, 59.5 and 0.05 for T1, T2 and T3, resp. First order rate constants for DMD were (% hr⁻¹) T1, 9.67; T2, 4.31; T3, 3.07. DMD of WS alone

was calculated by difference of DMD for 100% and 50% AH; by this estimate WS DMD was 2.23% hr⁻¹, with little lag. Mean ruminal pH was: T1: 7.22±0.34, T2: 7.22±0.20, T3: 7.25±0.23 (P>0.05), and by time after feeding (hr): 0: 7.42a±0.29, 2: 7.11c±0.27, 4: 7.20b±0.22, 8: 7.20b±0.22 and 12: 7.23b±0.23 (P<0.05) with little change in relation with 0 time. Total VFA were not different by diet: T1: 74.5±19.5, T2: 77.8±14.5, T3: 74.3±16.0 mM (P>0.05). Acetic acid (C2) 59.8±11.3, propionic acid (C3) 16.0±3.3, butyric acid 12.5±3.4 and isovaleric acid 0.20±0.46 mM were different by time after feeding (P<0.05). C2:C3 molar ratios were different by diet: T1: 3.84b±0.56, T2: 4.10a±0.54 and T3: 3.98b±0.68, and by sampling time (P<0.05). DMD of different quality forages by llamas is similar to other ruminants.

Key Words: Llamas, Rumen Digestion

1111 Effects of pH on microbial fermentation and nutrient flow in a dual flow continuous culture system. P.W. Cardozo, S. Calsamiglia*, and A. Ferret, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Eight 1325-mL dual flow continuous culture fermenters were used in two replicated periods (8 days) to study the effects of pH on microbial fermentation and nutrient flow. All fermenters were fed 95 g/d of a 60:40 forage to concentrate diet. Treatments were 8 different pH ranging from 4.9 to 7.0 (in .3 increases) and were randomly assigned to fermenters within period. Fermenters were maintained at 39°C, liquid and solid dilution rates were maintained at 10 and 5%/h respectively, and pH was controlled by infusion of 3N HCl or 5N NaOH. Results were analyzed for linear (L), quadratic (Q) and cubic (C) effects (P < .05). Cubic effects were observed for true digestion of OM (highest at pH 6.1, 54%; and lowest at 5.2, 35%), NDF (highest at pH 6.4, 37%; and lowest at pH 4.9, 12%) and ADF (highest at pH 6.1, 42%; and lowest at pH 5.2, 7%). Effects were Q for total VFA (highest at pH 7.0, 118 mM; and lowest at pH 4.9, 65 mM), L for acetate proportion (highest at pH 7.0, 71%; and lowest at pH 4.9, 51%), and C for propionate concentration (highest at pH 5.5, 35%; and lowest at pH 7.0, 15%), branched-chain VFA (highest at pH 7.0, 2.3%; and lowest at pH 5.5, .4%) and acetate to propionate ratio (highest at pH 7.0, 4.8; and lowest at pH 5.5, 1.5). Effects were C for ammonia N concentration (highest at pH 7.0, 14.1 mg N/dL; and lowest at pH 5.5, 3.2 mg N/dL), Q effects for bacterial N flow (highest at pH 6.4, 1.64 g/d; and lowest at pH 5.2, 1.0 g/d), L for dietary N flow (highest at pH 5.2, 2.03 g/d; and lowest at pH 6.7, 1.2 g/d). Crude protein degradation decreased linearly from 55% (pH 6.7) to 24% (pH 5.2). There were no pH effects on efficiency of microbial protein synthesis (mean of 36.7 g N/kg OM truly digested). Results indicated that microbial fermentation was optimal at pH between 6.1 and 6.7, and that most measurements followed a cubic response.

Key Words: Microbial fermentation, pH

1112 Inhibition of fungal feed enzyme activities by silage extracts. V.L. Nseroko*, D.P. Morgavi¹, K.A. Beauchemin¹, L.M. Rode¹, and A.F. Furtado¹, ¹*Agriculture and Agri-Food Canada.*

Researchers have noted that feed enzymes are generally less efficacious when applied to silages as opposed to dry feeds. The reasons for this phenomenon are not clear. We investigated the presence, in silage, of soluble factor(s) that inhibit *Trichoderma* hydrolases. Samples of 14 different whole crop barley silages were homogenised in buffer at their original pH, and the liquid extracts clarified by centrifugation (10000 g; 20 min). An enzyme preparation (Pro-Mote; Biovance Tech., Omaha) was diluted in each extract or buffer alone (control) at the same pH. These solutions were assayed for cellulase (EC 3.2.1.4), xylanase (EC 3.2.1.8) and amylase (EC 3.2.1.1) activities using remazolbrilliant blue dyed (RBB) carboxymethyl cellulose, RBB-xylan and RBB-starch, respectively as substrates. The extracts inhibited xylanase and amylase activities by 23 to 51% (P<0.05). Three extracts showed some inhibition of cellulase activity (12 to 25%) but the rest had no effect (P>0.05). An 8-fold dilution of 1 extract retained an inhibitory activity, against xylanase, of 25%; only a dilution of 16-fold restored activities to those measured in buffer alone. The inhibitors were not proteases since autoclaved silage extracts retained inhibitory activity. Low M_r filtrates of silage extracts (<10kDa) also retained inhibitory activity. Furthermore, inhibition was not related to levels of major organic acids or of total sugars present in the silages. With most available evidence suggesting that enzymic action is responsible for the beneficial effects of feed enzymes, the presence of hydrolase inhibitors may explain why these additives are

generally ineffective on silage diets. Additionally, since cellulase activity was relatively unaffected by silage extracts, these data may imply that exogenous cellulase activity is not a critical component of this particular feed enzyme preparation. We conclude that barley silages contain low M_r thermostable factor(s) that inhibit *Trichoderma* xylanase and amylase activity but have little effect on cellulases.

Key Words: Feed enzymes, Silage, Inhibitors

1113 Impact of a yeast culture, monensin or both on production of Holstein cows. L.J. Erasmus*¹, P.H. Robinson², R. Hinders³, and J.E. Garrett⁴, ¹*ARC - ANPI, Irene, RSA*, ²*UCCE, Davis, CA*, ³*Hinders Nutr. Cons., Acampo, CA*, ⁴*Diamond V Mills Inc., Cedar Rapids, IA.*

Several studies report increased lactation performance of dairy cows fed yeast cultures (YC; XP, DVM) and monensin (M). Sixty mature Holstein cows were supplemented with YC, M, both (YCM) or neither (C), for approximately 21 d prepartum and 56 d postpartum. Rumen fluid was collected from all cows by rumenocentesis twice prepartum and thrice postpartum. There were no treatment differences in prepartum performance. Postpartum DM intake (DMI) was lower for M cows, and data suggested the extent of the suppression increased as the absolute DMI of individual cows increased (r=.52). In contrast, a numerical decrease in DMI for YC and YC/M cows was due to lower DMI for individual cows with lower absolute DMI, while cows with higher absolute DMI had higher DMI compared to C cows (r=.81). Crossover was 21 kg/d DMI. Milk, fat and lactose yields were higher for YC cows, while YC/M cows produced less milk and protein. Data suggested the suppression in protein yield for M cows increased as the absolute protein yield of individual cows increased (r=.56). In contrast, similar production of protein in YC vs. C cows masked a suppression in individual cows with lower protein yields, and an increase in those with higher yields (r=.74). Crossover was .95 kg/d. YC/M cows were similar to YC. NEL output, and calculated ration NEL concentration, was higher for YC cows. All treatments had some effects on rumen fermentation parameters. Results suggest that YC had a greater positive effect on performance as the absolute performance of individual cows increased while the effect of M was the opposite, with both potentially mediated by changes in rumen fermentation. The effect of YC/M was, in general, intermediate. Findings could be interpreted to suggest that YC is a better choice than M in cows with higher performance potentials, whereas M is a better choice in cows with lower performance potentials.

Key Words: Yeast culture, Monensin, Energy density

1114 Ruminal fermentation and duodenal nutrient flow in sheep fed diets with different antibiotics. H. Febel*¹, S. Fekete², and Sz. Huszar¹, ¹*Research Institute of Animal Breeding and Nutrition, Herceghalom, Hungary*, ²*University of Veterinary Science, Budapest, Hungary.*

Even though many experimental investigations have been performed and published on the effects of antimicrobial agents on ruminal digestion, limited information is available detailing the connection between antibiotics and diet composition. The purpose of this study was to determine the ruminal effects of antibiotics dependent on diet. Nine wethers (62 kg) with cannulas in the rumen and proximal duodenum were used to study the effects of two different types of antimicrobial, salinomycin (S) and flavophospholipol (F) on characteristics of ruminal digestion. The influence of antibiotics was evaluated in animals fed three different amounts of rumen degradable protein (RDP) and nonstructural carbohydrate (NSC): high, 74% RDP-38% NSC (H), medium, 57% RDP-32% NSC (M), and low, 48% RDP-23% NSC (L). The treatments were applied in a 3x3 factorial arrangement of three levels of RDP and NSC (H, M, L) and three levels of antibiotic/animal/day supplementation (zero, 43 mg S, 22 mg F). Addition of S, independent of diet composition, decreased ruminal acetate:propionate ratio and ammonia concentration (P<.001). Ruminal ammonia content was lower (P<.01) in sheep fed on H diet with F. S supplementation, regardless of RDP and NSC contents of the diet, decreased (P<.05) the microbial N flow to the duodenum, the efficiency of microbial protein synthesis and ruminal degradation of dietary N, and these changes were associated with higher dietary N passage (P<.05). In contrast, F had no effect (P>.05) on the efficiency of microbial protein synthesis and improved N degradation in the rumen. The effect of F on the microbial breakdown of dietary protein was dependent on the feed composition. F increased (P<.05) the ruminal

degradation of protein in sheep fed M and L diets. This antimicrobial decreased ($P < .05$) the bypass dietary N flow to the duodenum in sheep fed diet L. It seems that the effect of F was more dependent on dietary RDP and NSC contents than that of S.

Key Words: Salinomycin, Flavophospholipol, Sheep

1115 Ruminal fermentation and flow of nutrients to the duodenum in goats fed ionophores and animal fat. H.V. Janacua*¹, C.V. Villalobos¹, C.S. Velez¹, F.A. Rodriguez¹, and A.D. Alarcon-Rojo¹, ¹University of Chihuahua, Chihuahua, Mexico.

Five criollo goats (mean BW 35 kg) cannulated in rumen and duodenum were arranged in a 5 X 5 Latin square design to evaluate the influence of animal fat and ionophore on intake, digestion, and nutrients flow to the duodenum using Cr and purine bases as flow and microbial markers. Treatments were 1) control (no added fat or ionophore); 2) lasalocid (CL), lasalocid 33 ppm a/d; 3) monensin (CM), monensin 33 ppm a/d; 4) fat (CF), animal fat 3% DM; and 5) fat plus monensin (CFM). Supplements were offered at 0700 and 1900 h daily. Ruminal pH were not different ($P > .05$) among diets (average 6.4). Ruminal ammonia concentrations were 16.5 to 20.4 mg/L, and did not differ between treatments ($P > .05$). Ruminal VFA concentration were not different ($P > .05$) among treatment; initial, peak, and average values were 85 to 110, 104 to 146, and 100 to 117 mm/L, respectively. Ruminal digestion of OM averaged 52% and was lower ($P < .05$) when goats were fed CM diet. There were no differences ($P > .05$) between CL and CFM in ruminal degradability of feed N. However, microbial N synthesis was greater ($P < .05$) for the CM treatment. The flow of microbial N to the duodenum was higher ($P < .05$) when goats were fed CFM and CF diets than when they were fed other diets. These data indicate that supplementation with animal fat and ionophore in diets for goats had minimal effects on digestion characteristics.

Key Words: Animal Fat, Digestion, Protein Synthesis

1116 Effect of Monensin on protein fermentation of some feed sources. L. T. Cunha, R. P. Lana*, A. C. Borges, and J. S. Oliveira, Universidade Federal de Vicosa, Vicosa-MG, Brazil.

This research evaluated the effect of Monensin on protein degradation of soybean meal, wheat meal and corn meal. Ruminal fluid was taken from a fistulated steer on a 40% concentrate diet and centrifuged at 500g for 15 minutes to remove feed particles and protozoa. The incubations were performed in an anaerobic environment at 39°C using 100 mg of feed, 14.7 mL of ruminal fluid and 0.3 mL of ethanol with or without dissolved Monensin (5 μ M as final concentration). The soybean meal resulted in ($P < 0.05$) higher amounts of ammonia production, microbial protein and final pH compared with wheat meal and corn meal. The greater ammonia production was due to higher protein content and high degradability of the soybean meal and with higher media pH that stimulates deamination. Wheat meal had greater final pH than corn meal ($P < 0.05$). Monensin decreased the protein degradability ($P < 0.05$), although it was more effective in reducing protein degradation at higher pH values. Monensin increased efficiency of protein utilization by ruminants in diets with high protein and carbohydrate rates of fermentation and high ruminal pH, as would be true of pastures with young grasses and forage legumes.

Key Words: Ammonia, Monensin, pH

1117 Effect of thymol on ruminal microorganisms. J. D. Evans* and S. A. Martin, University of Georgia, Athens.

Thymol is a phenolic compound that is used to inhibit oral bacteria. Because little is known regarding the effects of this compound on ruminal microorganisms, the objective of this study was to determine the effect of thymol on growth and lactate production by the ruminal bacteria *Streptococcus bovis* JB1 and *Selenomonas ruminantium* HD4. In addition, the effect of thymol on the in vitro fermentation of glucose by mixed ruminal microorganisms was investigated. Neither 45 or 90 μ g/ml of thymol had any effect on growth or lactate production by *S. bovis* JB1, but 180 μ g/ml of thymol completely inhibited growth and lactate production. Increasing concentrations of thymol decreased ($P < 0.05$) glucose uptake by whole cells of *S. bovis* JB1 in a dose response manner. In the case of *S. ruminantium* HD4, 45 μ g/ml of thymol had little effect on growth and lactate production. However,

90 μ g/ml of thymol completely inhibited growth of *S. ruminantium* HD4. When mixed ruminal microorganisms were incubated in medium that contained glucose, 400 μ g/ml of thymol increased ($P < 0.05$) final pH and the acetate:propionate ratio and decreased ($P < 0.05$) concentrations of methane, acetate, propionate, and lactate. In conclusion, thymol was a potent inhibitor of glucose fermentation by *S. bovis* JB1 and *S. ruminantium* HD4. Even though thymol treatment decreased methane and lactate concentrations and increased final pH in mixed ruminal microorganism fermentations of glucose, concentrations of acetate and propionate were also reduced.

Key Words: thymol, ruminal microorganisms, in vitro

1118 Extruded-expelled cottonseed meal with lint as a source of rumen undegradable protein for lactating dairy cows. M.J. Meyer*, J.E. Shirley, A.F. Park, M.J. VanBaale, and E.C. Titgemeyer, Kansas State University, Manhattan.

Twenty-four multiparous Holstein cows (121 \pm 23 DIM) averaging 40.8 kg/d energy corrected milk (ECM) were used in six 4x4 Latin squares with 21-d periods to evaluate extruded-expelled cottonseed meal (EC) as a source of rumen undegradable protein (RUP). Cows were blocked according to pretreatment milk yield and bodyweight and fed similarly prior to assignment to the following diets: 16% crude protein (CP), 35% RUP (SBM16); 18% CP, 35% RUP (SBM18); 16% CP, 40% RUP using EC (EC16); 16% CP, 40% RUP using a fish meal-blood meal blend (FB16). Diets with 35% RUP contained solvent soybean meal as the primary protein source. Alfalfa hay and corn silage were included in the diets at 25 and 20% of DM, respectively. Ground corn grain was the primary cereal grain. EC16 contained 8.4% EC and FB16 contained 3.2% fish meal and 0.8% blood meal (DM basis). Milk production by cows fed SBM16, SBM18, EC16, and FB16 was 36.7, 37.6, 37.2, and 37.2 kg/d, respectively, with no diet effect ($P > .05$). DM intakes for cows fed SBM16, SBM18, EC16, and FB16 were 29.7, 29.6, 29.3, and 28.0 kg/d, respectively, with cows fed FB16 consuming less than ($P < .05$) cows fed the other diets. Cows fed FB16 were the most efficient producers of milk ($P < .05$), with others being equal. Somatic cells and percent milk fat, protein, casein, and SNF were not affected by diet, but percent lactose in milk was lowest ($P < .05$) for cows fed EC16. MUN was similar between EC16 and FB16, but both were lower ($P < .05$) than SBM18. MUN for cows fed SBM16 was lower than SBM18 ($P < .05$), higher than EC16 ($P < .05$), and similar to FB16. Bodyweight, BCS, and plasma NEFA, glucose, and total alpha-amino N were not influenced by diets. Plasma urea N was higher ($P < .05$) for SBM18 than other diets. Results of this study suggest that extruded-expelled cottonseed meal with lint can be substituted for soybean meal or a fish meal-blood meal blend without affecting performance.

Key Words: Dairy, Extruded-Expelled Cottonseed, Rumen-Undegradable Protein

1119 Determination of the amount of wet corn gluten feed to include in diets for lactating dairy cows. M.J. VanBaale*¹, J.E. Shirley¹, E.C. Titgemeyer¹, M.J. Meyer¹, A.F. Park¹, R.U. Lindquist², and R.T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc.

Twenty-four multiparous Holstein cows were blocked according to pretreatment milk yield, DIM, and bodyweight and used in six 4 x 4 Latin squares with 28-d periods to determine inclusion rates for wet corn gluten feed (WCGF) in diets for lactating dairy cows. Cows were housed in a tie stall barn and fed diets to meet or exceed NRC (1989) nutrient requirements. Diets were formulated to be isonitrogenous and isocaloric and fed twice daily as a total mixed ration. Treatments were 0, 20, 27.5, and 35% WCGF (DM Basis). WCGF was substituted in the diets for a portion of the alfalfa hay, corn silage, corn grain, and soybean meal. Milk yield (kg/d) and DMI (kg/d) for cows fed 0, 20, 27.5, and 35% WCGF were 37.8, 26.8; 41.6, 27.7; 41.6, 27.9; and 41.6, 26.5; respectively. Cows fed WCGF produced more ($P < .01$) milk, ECM, and 4% FCM than cows fed the control diet, but these parameters did not differ among cows fed 20, 27.5, and 35% WCGF. Cows fed 0 and 35% WCGF had similar DMI as did those fed 20 and 27.5%. However, cows fed 20 and 27.5% WCGF consumed more DM ($P < .01$) than those fed either 0 or 35% WCGF. Cows fed 20 and 27.5% WCGF produced ECM more efficiently ($P < .01$) than those fed the control diet, and those fed 35% WCGF were more efficient ($P < .01$) than all others. Fat percent in milk was less ($P < .01$) from cows fed WCGF, but feeding WCGF did not

effect percent protein, lactose, and SNF, however total protein (kg/d) increased ($P < .01$) relative to control. Plasma glucose, total alpha-amino N, and total triglycerides were similar among diets, but PUN increased ($P < .01$) when cows consumed WCGF. Bodyweight, condition, and SCC were not affected by treatment. WCGF stimulated milk yield and improved efficiency of production when substituted in the diet for a portion of the forage, grain and protein supplement.

Key Words: Dairy, Wet Corn Gluten Feed

1120 Portal-drained visceral (PDVF) flux and mammary uptake (MU) of free (FAA) and peptide-bound amino acids (PBAA) in lactating cows fed diets containing steam flaked corn (SF) at 360 or 490 g/l. H. Tagari¹, K. Webb², B. Therer³, T. Huber³, P. Cuneo³, D. Deyoung³, A. Delgado-Elorduy³, M. Sadik³, A. Alio³, O. Lozano³, J. Simas³, C. Nussio³, P. Pu³, F. Santos³, and J. Santos³, ¹Hebrew University of Jerusalem, ²Virginia Tech, Blacksburg, ³University of Arizona, Tucson.

PDVF and MU of FAA and PBAA were quantified in six lactating Holstein cows fed TMR with 40% SF360 or SF490 at 12-h intervals in a crossover design. Blood was sampled via indwelling catheters in portal and milk veins and in costabdominal or mesenteric arteries every 2 h. DMI, NI, PDV and mammary plasma flows were similar for both diets and averaged 18.3 kg/d, 0.48 kg/d, 1392 l/h, and 399 l/h, respectively. Milk (28.3 vs. 26.9 kg/d; $P < 0.05$) and milk CP (0.86 vs. 0.785 kg/d; $P < 0.069$) yields differed for SF360 and SF490. PDVF of FAA and PBAA was greater in SF360 but the PDVF of PBAA as a proportion of FAA was greater in SF490 (14.2%) than for SF360 (11%). Amino acids with the greatest percentage PDVF occurring as PBAA, included HIS (27-59%), THR (26-55%), LYS (18-20%) and VAL (10-27%). MU of FAA and PBAA was greater for cows fed SF360, thus reflecting differences in milk and milk CP yields. LYS seems to be the first limiting AA as reflected by the greatest proportional uptake from the PBAA fraction, being 20 to 31% of free LYS uptake. The large MU of PBMET in excess of needs for milk production may be explained by its need for other metabolic purposes. PBAA appearing in the mammary vein may be the result of mammary degradation of plasma proteins.

Item, Diet, Pool	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL
PDVF, SF360, FAA	60.8	19.0	58.2	94.1	60.2	32.8	60.7	40.2	26.3	65.2
PDVF, SF360, PBAA	-4.7	11.2	5.6*	9.4	10.5*	-2.1	-3.9	10.6*		17.6*
PDVF, SF490, FAA	42.1	13.3	37.0	59.8	41.4	19.1	44.3	28.3	9.3	37.5
PDVF, SF490, PBAA	-9.3	3.6	7.0*	6.9	8.3*	-0.5	1.2	15.7		3.7
Milk, SF360	14.0	11.0	22.2	39.0	32.7	10.8	20.8	17.3		25.2
Milk, SF490	12.4	9.7	19.7	34.5	28.1	9.5	18.4	15.4		22.4
MU, SF360, FAA	27.8	10.5	29.5	48.3	24.4	9.3	20.2	14.9	4.9	34.9
MU, SF360, PBAA	3.8	-0.5	0.6	2.8	7.6	6.2	0.8	3.3		0.8
MU, SF490, FAA	24.7	8.4	25.7	43.3	21.3	9.3	17.6	14.4	6.0	28.8
MU, SF490, PBAA	3.0	0.4	-2.4	-0.1	4.3	2.9	-1.1	-0.9		1.2

Units = g/12h. **Bold** or with *, values differ from zero at $P < .05$ or $P < .09$, respectively.

Key Words: Mammary Gland, Absorption

1121 Portal-drained visceral flux (PDVF) and mammary uptake (MU) of free (FAA) and peptide-bound amino acids (PBAA) in lactating cows fed diets containing steam flaked (SFS) or dry rolled (RDS) sorghum. H. Tagari¹, K. Webb², B. Theurer³, T. Huber³, P. Cuneo³, D. Deyoung³, A. Delgado-Elorduy³, M. Sadik³, A. Alio³, O. Lozano³, J. Simas³, C. Nussio³, P. Pu³, F. Santos³, and J. Santos³, ¹Hebrew University of Jerusalem, ²Virginia Tech, Blacksburg, ³University of Arizona, Tucson.

PDVF and MU of FAA and PBAA were quantified in eight lactating Holstein cows fed TMR with 40% SFS or DRS at 12-h intervals in a crossover design. Blood was sampled via indwelling catheters in portal and milk veins and in costabdominal or mesenteric arteries every 2 h. DMI, NI, were: 16 and 18 and .45 and .51 kg/24h on SFS and DRS diets and milk yield and milk CP yields were 27.7 vs. 26.5 and 0.85 vs. 0.792 kg/d. PDVF and mammary plasma flows were similar for both diets at 1,287±183 and 399±62 l/h. PDVF of FAA was similar for both diets but that of PBAA was 18.6% of PDVF of FAA in SFS compared with 9.3% in DRS (about half the SFS diet). The highest proportion of PDVF of PBAA was HIS, averaging 68% for both diets. Proportions of LYS and VAL differed for both diets. LYS was higher for SFS than DRS (55% vs 29%) and the opposite was true for VAL with DRS having the higher value (DRS, 12% vs SFS, -10%). The effect ($P < .05$) of SFS diet on PDVF of PBARG and PBLEU may indicate that these PBAA are a result of the effect of the diet and are not residues from metabolism. Extensive MU of PBLYS was observed in both treatments to furnish the shortage of this FAA in the plasma. PBAA appearing in the mammary vein may be the result of mammary degradation of plasma proteins.

Diet, Tissue, Pool	ARG	HIS	ILE	LEU	LYS	MET	PHE	THR	TRP	VAL
DRS, PDVF, FAA	38.4	11.7	43.3	74.5	35.4	18.7	44.8	29.8	11.8	48.9
DRS, PDVF, PBAA	3.5	7.9	-1.9	4.4	10.1	6.0	3.0	3.2		-4.7
DRS, Milk	12.8	9.8	20.1	35.1	30.5	9.8	18.5	15.7		22.8
DRS, MU, FAA	24.5	8.6	26.5	46.7	22.7	11.4	18.0	13.5	6.0	29.4
DRS, MU, PBAA	1.3	1.5	-0.8	-0.7	5.4	0.7	1.0	0.6		0.1
SFS, PDVF, FAA	33.1	13.9	39.7	65.1	27.3	14.6	38.8	24.7	13.7	56.5
SFS, PDVF, PBAA	4.2	9.5	10.4	8.4	14.9	1.2	-1.6	7.5		6.4
SFS, Milk	14.1	10.9	21.8	37.9	33.0	10.6	20.2	16.8		24.7
SFS, MU, FAA	24.1	9.3	28.8	44.0	21.7	12.6	19.2	14.8	8.0	26.4
SFS, MU, PBAA	-1.1	-2.5	1.2	0.8	2.3	1.6	0.3	-0.2		-0.9

Units = g/12h. **Bold** values differ from zero at $P < .05$.

Key Words: Mammary Gland, Absorption

1122 Effects of duodenal infusion of graded amounts of Phe on mammary uptake and metabolism in dairy cows. H. Rulquin¹ and P.M. Pisulewski², ¹UMRPL INRA, St Gilles, France, ²Agricultural Univ., Cracow, Poland.

Phe is one of the proposed limiting amino acids for dairy cow. However, its requirement and the dynamic of its metabolism in the mammary gland are poorly documented. A 4x4 Latin square was realized to study effects of duodenal infusion of graded amounts of Phe (0, 6, 21, and 37 g/d) during 4 days on mammary uptake and milk secretion in Holstein cows. Diet covered 100 and 75% of energy and protein requirements. An extra duodenal infusion of 430 g/d of free Phe mixture of Met, Lys, Thr, Leu, Trp, Val, Ile, His, Arg, Tyr and Glu was used to meet 110% of protein requirements. Supply of Phe provided 75, 100, 125, and 150% of the expected requirements for the 4 treatments respectively. Cows

equipped with a duodenal cannula and an ultrasonic blood flow probe fitted around a pudic artery were sampled for arterial (carotid) and venous blood (subcutaneous) 6 times during 12 hours. Milk yield was unaffected by infusions. True protein concentration of milk increased significantly to a plateau at the second dose infused (3.22, 3.35, 3.40, and 3.35 %). Arterial concentrations of Phe and Tyr in plasma increased linearly for Phe and quadratically for Tyr (0.65, 0.74, 0.86, and 0.87 mg/100 ml for Phe; 0.65, 0.74, 0.86 and 0.87 mg/100ml for Tyr). Mammary extraction rate linearly decreased (62, 53, 38, and 35% for Phe; 47, 43, 38, and 33% for Tyr), whereas mammary uptakes were not significantly affected. Ratio of plasma uptake of Phe and Tyr to milk output were always close to 1 (0.99, 1.01, 0.78, and 1.07 for Phe; 1.04, 1.03, .84, and 0.90 for Tyr). It is concluded that 1) mammary uptakes of Phe and Tyr are independent from their arterial levels, 2) optimum of dietary Phe concentration is located between 4.6 and 5.8% of the truly digested in the small intestine (PheDI) in proteins truly digested in the small intestine (PDI).

Key Words: Phe, Mammary metabolim, Dairy cow

1123 A blood procedure to determine bioavailability of rumen-protected Met for ruminants. H. Rulquin^{*1} and J. Kowalczyk², ¹UMRPL INRA, St Gilles, France, ²IFZZ, Jablonna, Poland.

In vitro or in sacco methods used to test the efficiency of process of protection of amino acids against ruminal degradations are not satisfactory because liquid or pulverulent products can not be tested, and differences in intestinal absorption are not evaluated. An in vivo method based on blood responses was tested on six commercial products. The principle of the method is to predict the bioavailability of Met provided by a rumen-protected product from a blood response-curve calibrated with duodenal infusions of graded doses of crystalline Met. Animal response calibration, and tests of commercial products were performed on three dried-off cows fitted with rumen and duodenum cannula by infusing water, 3, 15, 20 and 30g of D-L Met, or by introducing protected products in the rumen twice a day, 15 min after meals. Code of products, process of protection, Met content and amounts supplied were respectively: A (pH-sensitive coating, 78%, 30g/d), B (pH-sensitive coating, 17%, 76g/d), C (fat coating, 26%, 50g/d), D (fat and ethyl-cellulose encapsulation, 85%, 24 g/d), E (fat coating, 54%, 50g/d), and F (Zn-chelating and fat coating, 30%, 66g/d). Each supplement was given during four days, and the last day blood samples were withdrawn every six hours during 12 h through a catheter inserted in the jugular. Met was dosed on a pooled sample of deproteinized plasma by ion exchange chromatography. Results were tested by variance and covariance analysis. Calibration curve was linear and not significantly different between cows (Met supplied = $0.287 \pm 0.05 + (0.039 \pm 0.003) \times \text{Met mg/100ml plasma}$; $R^2 = 0.96$, $SE = 0.12$). Met bioavailability of the products is A=75, B=65, C=-1, D=16, E=0 and F=30%. With a standard error of mean of 11%, differences are significant ($P < 0.05$) for products A and B vs. the others, and C vs. F. The calibration used in this procedure permits the measurement of the absolute value of bioavailability of Met of rumen-protected products. Using four cows will allow detecting differences in bioavailability between products of 20%.

Key Words: Rumen-protected Met, Bioavailability, Dairy cow

1124 The effect of rumen protected methionine on milk production and milk composition in first lactation Holstein cows fed high protein diets. J. D. Ferguson^{*1}, B. Veccharelli¹, J. Beach¹, and S. Takenaka², ¹University of Pennsylvania, Kennett Square, ²Nisso America, Inc. New York, NY.

Forty seven first lactation animals were randomly assigned to one of two precalving diets and postcalving diets to examine the effects of rumen protected methionine (RPMET) on production and reproduction. Precalving diets contained 15.3% CP and 1.56 mcg/kg of net energy. At calving, cows were randomly assigned to diets containing 17.5% CP with 38% of the protein as RUP and a net energy of 1.72 mcg/kg. Ration ingredients were mixed together in a TMR and offered once a day to 10% feed refusal. Both precalving and postcalving, one group of animals received a top dress of .45 kg of ground corn containing 20 g of RPMET (Met-PlusR) and the other group received a top dress of .45 kg of ground corn alone. Animals were fed the precalving diets for 21 to 60 days prior to calving. Lactating cows were fed the RPMET through 100 days post calving. Feed intake was measured daily for each group of 12

animals. Milk production was measured twice a day. Body weight and body condition score was measured weekly. Once a week, milk samples from a.m. and p.m. milking were composited, preserved with bronopol, and analyzed for fat, crude protein, true protein, milk urea nitrogen, and solids not fat by the PA DHIA milk testing laboratory, University Park, PA. Results were as follows: Values (sem) with different superscripts in same column differ by $p < .10$.

Dietary Treatments	Milk, kg	Fat, %	CP,%	TrProt,%
MET-MET	28.5a	3.85	3.25a	3.13ac
No-No	28.8a	3.58	3.18b	3.06a
MET-No	27.6a	3.81	3.26a	3.17bc
No-MET	25.8b	3.70	3.34a	3.24b

Key Words: Methionine, Rumen protected, Production

1125 Effect of source of bypass protein and supplemental Alimet[®] and Lysine-HCL on lactation performance. J. H. Harrison^{*1}, D. Davidson¹, L. Johnson¹, M. L. Swift², M. von Keyserlingk², M. Vazquez-Anon³, and W. Chalupa⁴, ¹Washington State University, Puyallup, ²Agro Pacific Ind., Ltd., Chilliwack, B.C., Canada, ³Novus, Int., St. Louis, MO, ⁴University of Pennsylvania, Kennett Square.

Two commercially available bypass protein sources (ProlakTM- animal based, H J Baker and Ami ProTM vegetable based, Pro Form Feeds) were compared with and without added lysine HCL and Alimet[®] feed supplement. Diets were formulated with CPM Dairy to meet 100 % of required Met and Lys (diets Ami ProTM and ProlakTM) or 116 % of Met and 106 % of Lys (diets Ami+ and Pro+). Respective diets were fed from 3 wk prepartum through wk 17 postpartum to 98 Holstein cows in a continuous trial design. Cows were fed individually via Calan headgates. Detailed data are summarized below. No statistical differences were observed between bypass protein sources with or without supplemental Lys and Met. However, trends were for increased Milk, FCM, and yield of components when either protein source was supplemented with Lys and Met. Cows yielded the greatest (numerically) amount of Milk, FCM, and components when fed ProlakTM plus supplemental Lys and Met.

Item	Amipro TM	Ami+	Prolak TM	Pro+	SE	P <
DMI, kg	21.95	21.83	22.16	21.69	.6	NS
Milk, kg	38.78	38.87	39.57	39.75	1.32	NS
3.5% FCM, kg	39.51	39.8	40.59	41.4	1.31	NS
Milk fat, kg	1.4	1.42	1.45	1.49	.05	.11
Milk protein, kg	1.19	1.19	1.22	1.3	.06	NS

[®] Registered trademark of Novus Int., St. Louis, MO.

Key Words: Protein, Milk, Amino acids

1126 Metabolism of 2-hydroxy-4-methylthio butanoic acid (HMB) in growing lambs. T.J. Wester¹, M. Vazquez-Anon², D. Parker², J. Dibner², A.G. Calder¹, and G.E. Lobley^{*1}, ¹Rowett Institute, Aberdeen, UK, ²Novus International, St. Louis, MO.

HMB is an effective source of methionine (Met) in non-ruminant diets although the sites of its metabolism remain unclear. The objective of the current study was to examine the extraction of HMB by the liver and the consequences on Met metabolism in ruminants. Four sheep (initial body weight 50 kg) were prepared with catheters in the aorta, mesenteric, portal, hepatic and jugular veins plus the abomasum. To ensure metabolic steady state sheep were fed hourly at 1.5 x maintenance on a grass hay, barley, fishmeal, molasses/premix (5:3:1:1) diet. Animals were infused for 12 h with [1-13C]Met in a jugular vein and, from 3 h onwards, successive 3 h infusions of saline (control), 0.55 mg/min and 4.4 mg/min HMB into the mesenteric vein. Plasma samples, collected continuously, were taken every 20 min during the last 80 min of each infusion. All infused HMB was recovered at the portal vein but 25% was extracted subsequently by the liver. Portal appearance of Met and cystine (Cys) was unaltered by HMB infusion. Net splanchnic output of Met, however, decreased (0.14, -0.01, -0.21 mmol/h, SED 0.07, $P = 0.02$) while that of Cys increased (0.04, 0.08, 0.23 mmol/h, SED 0.07, $P = 0.07$) with increasing rates of HMB infusion. Despite the lack of release of dietary Met into the peripheral circulation arterial concentrations of Met increased (27.0, 30.7, 51.5 uM, SED 3.0, $P < 0.001$) as did Met irreversible loss rate (1.78, 1.84, 2.53 mmol/h SED 0.15, $P <$

0.001). The increase in Met irreversible loss rate was the equivalent of 40% of the HMB delivered beyond the liver entering the plasma Met pool following metabolism by peripheral tissues. These data indicate that the liver does not secrete into circulation the Met derived from the extracted HMB although it may contribute to increase Cys output. The results also suggest that HMB is being extensively metabolised by extra-hepatic tissues.

Key Words: HMB, Methionine, Absorption

1127 Synthesis of methionine (Met) from 2-hydroxy-4-methylthio butanoic acid (HMB) in growing lambs. T.J. Wester¹, M. Vazquez-Anon², D. Parker², J. Dibner², A.G. Calder¹, and G.E. Lobley^{*1}, ¹Rowett Institute, Aberdeen, UK, ²Novus International, St. Louis, MO.

Previous data have suggested that HMB is converted to Met by peripheral tissues in sheep. This was examined by following the metabolism of [1-¹³C]HMB. Four sheep (initial body weight 50 kg) were prepared with catheters in the aorta, mesenteric, portal, hepatic and jugular veins plus the abomasum and fed at 2.5 × maintenance on a grass hay, barley, fishmeal, molasses/premix (5:3:1:1) diet. To ensure metabolic steady state the diet was fed as hourly meals. Sheep were infused with unlabelled HMB (1.1 mg/min) into the abomasum for 24 h followed by [1-¹³C]HMB for 6h, during which time [2H₃]methionine was infused into the mesenteric vein. During the last 2 h of infusion continuously withdrawn plasma samples were collected at 30 min intervals from the aorta, portal and hepatic veins. Recovery of infused HMB was 75% at the portal vein, with 36% of this extracted by the liver. HMB contributed 10% to overall Met irreversible loss rate (2.8 mmol/h) which was equivalent to 40% of absorbed Met (0.67 mmol/h) and similar to the amount of HMB that appeared beyond the liver (0.21 mmol/h). Enrichment of [1-¹³C]Met was greater in arterial than in either portal or hepatic plasma (8.94, 7.37, 7.61 molar % excess, SED 0.17, P < 0.001). The ratio of 13C:2H₃ Met enrichments was also greater in arterial than portal or hepatic plasma (2.19, 1.75, 1.54, SED 0.094, P = 0.001). These data suggest the involvement of post-splanchnic tissues in the synthesis of Met from HMB. This was confirmed from analysis of the 13C:2H₃ free Met enrichments from visceral tissues where Met synthesised from HMB represented from 22 to 26% (P < 0.001) of Met present within the cells (kidney > liver > rumen > jejunum > duodenum > ileum). Other peripheral tissues (lung, brain, muscle, skin) also synthesised Met from HMB but this represented a smaller proportion (<5% of intracellular Met). These results indicate that HMB is being converted to Met and used directly to meet tissue requirements.

Key Words: HMB, Methionine, Amino acid metabolism

1128 Dipeptides or their amino acids administered to a perfused area of the skin in Angora goats. R. Puchala¹, S.G. Pierzynowski², T. Wuliji¹, A.L. Goetsch¹, S.A. Soto-Navarro¹, T. Sahlui¹, and M. Lachica³, ¹E (Kika) de la Garza Institute for Goat Research, Langston, OK, ²Dept. Of Zoophysiology, Lund University, Lund, Sweden, ³Animal Nutrition Department, Estación Experimental del Zaidín (CSIC), Armilla, Spain.

Effects of infusion of dipeptides or their amino acids on mohair growth of Angora goats were investigated using a skin perfusion technique. Six Angora wethers (average BW 30 ± 3 kg) were implanted bilaterally with silicon catheters into the superficial branches of the deep circumflex iliac artery and into the deep circumflex iliac vein. For the first 14 d of the experiment, animals were infused into the deep circumflex iliac arteries with a mixture of Met-Leu and Lys-Leu on one side and similar amounts of free amino acids on the other side. The infusion rate of dipeptides were .85 mg Met-Leu and .85 mg Lys-Leu/h in 2.4 ml saline. Infusion rates of amino acids were .474 mg Lys, .483 mg Met and .743 mg Leu/h in 2.4 ml saline. The area of skin supplied by the deep circumflex iliac artery was approximately 300 cm². An area of 100 cm² within the perfused region was used to determine mohair growth. Two weeks after the cessation of infusions, perfused areas were shorn. Greasy mohair production from the perfused region was similar for dipeptide infusion compared with free amino acids (5.56 vs 5.69 g/100 cm² for the 28 d period, respectively, P > .1). However, mohair production was relatively higher than that observed when only saline was infused for 28 d preceding the experiment (4.71 g/100 cm²). No significant changes were observed in concentrations of amino acids, glucose or hormones in blood from the deep circumflex iliac vein (P > .1). In conclusion, the effects of

supplementing mohair-producing skin with limiting amino acids given in the free form and as small peptides, had similar effect on mohair growth.

Key Words: Peptide and Amino Acids, Skin Perfusion, Mohair

1129 Action of hydroxy methyl butanoic acid (HMB) on microbial growth and metabolism. B. K. Sloan^{*1}, W. H. Hoover², T. K. Miller Webster², C. G. Schwab³, and N. L. Whitehouse³, ¹Aventis Animal Nutrition, Alpharetta, GA, ²West Virginia University, Morgantown, ³University of New Hampshire, Durham.

The effect on ruminal fermentation parameters of three HMB concentrations (0, 0.11, and 0.22 % of DM) were tested on two diets in a continuous culture system (Stern and Hoover, 1990). Diets 1 (CORN) and 2 (BARLEY) contained respectively (% of DM) : corn silage (31.3, 31.3), haycrop silage (14, 14), soyhulls (6.0, 0), ground corn (25.3, 5.5), barley (0, 26.7), whole cottonseed (0, 7.4), soybean meal (11.5, 4.4), SoyPassTM (5.7, 2.2), bloodmeal (0, 2.1), AlifetTM (2.8, 0.5), tallow (0, 0.7), mineral vitamin premix (3.6, 3.4) and were designed to satisfy the energy and protein requirements of a dairy cow producing 45 kg of milk. Diets were as fed during an accompanying dairy trial (Johnson et al 1999). The six rations were fermented in continuous culture operated with a 12% liquid and 4.2% solids dilution rate. There were 4 replicates per treatment. Main effects were analysed as a 3*2 factorial. CORN diets were more completely digested (P<0.01) than BARLEY diets (DM; 69.8 vs 63.6, OM; 49.6 vs 44.2, ADF; 41.7 vs 30.1, NDF; 47.3 vs 42.4, CP; 65.5 vs 58.5). The following HMB results are all presented in order of increasing dietary concentration of HMB. The intermediate HMB concentration resulted in elevated digestibility (quadratic effect) of CP (59.1 vs 69.5 vs 57.4 ; P<0.01), increased non ammonia nitrogen flow (2.69 vs 2.76 vs 2.64 g/d ; P<0.07), increased microbial-N production (1.44 vs 1.83 vs 1.35 g/d ; P<0.01) and a reduction in fermenter ammonia levels (10.3 vs 8.3 vs 11.5 mg/dl ; P<0.01), resulting in an increase in microbial protein efficiency (33.1 vs 40.4 vs 32.4 g N/kg OM digested ; P<0.01). Volatile fatty acid concentrations and proportions were unaffected by level of HMB. Irrespective of diet type, the results indicate there is an optimum concentration of dietary HMB (0.11%) that facilitates an improvement in protein digestion and assimilation of N into microbial protein.

Key Words: HMB, Microbial protein efficiency, Continuous culture

1130 Deoxyribonuclease activity in the ruminal bacteria *Selenomonas ruminantium* and *Streptococcus bovis*. S. F. Al-Khaldi, L. L. Durocher, and S. A. Martin^{*}, University of Georgia, Athens.

Six *Selenomonas ruminantium* strains (132c, JW13, SRK1, 179f, 5521c1, and 5934e) and *Streptococcus bovis* JB1 were examined for nuclease activity as well as the ability to utilize nucleic acids, ribose, and 2-deoxyribose. Nuclease activity was detected in sonicated cells and culture supernatants for all bacteria except *S. ruminantium* JW13 and 179f sonicated cells. *S. ruminantium* strains were able to utilize several deoxyribonucleosides, while *S. bovis* JB1 showed little or no growth on all deoxyribonucleosides. When *S. ruminantium* strains 5934e, 132c, JW13, and SRK1 were incubated in medium that contained 15 mM ribose, acetate, propionate, and lactate were the major end products. *S. ruminantium* 5521c1 and *S. bovis* JB1 did not grow on ribose, and none of the *S. ruminantium* strains or *S. bovis* JB1 grew on 15 mM 2-deoxyribose. In conclusion, all *S. ruminantium* strains and *S. bovis* JB1 had nuclease activity. However, not all bacteria were able to utilize deoxyribonucleosides, ribose, or 2-deoxyribose. More research is needed to characterize the proteins involved in DNA degradation as well as the metabolism of deoxyribonucleosides and ribose in these bacteria. In particular, understanding how DNA is degraded and metabolized by *S. ruminantium* may lead to the construction of a transformable mutant.

Key Words: ruminal bacteria, nuclease, deoxyribonucleosides

1131 The effects of cutting height on nutritive value of corn silage. A. Garcia^{*}, C. Velázquez, P. Marinho, K. Cresci, I. Garmendia, and J. Piaggio, Facultad de Veterinaria. Montevideo, Uruguay.

The purpose of this study was to determine if the increase in corn silage nutritive value resulting from a higher length of cut offsets the decrease in total dry matter (DM) and thus digestible nutrient yields. Corn at

half milk stage was hand harvested and chopped with a one-row forage harvester leaving stubbles in the field of 15 (LC) and 90 (HC) cm. Total DM yield was determined by cutting and weighing representative areas from both treatments. Treatments were then ensiled in microsilos and allowed to ferment for 41 days. No differences in pH between treatments were found. Treatment LC yielded 28% more DM per hectare, had more NDF (46.5 vs 42.3%) and ADF (25.2 vs 19.5%) than HC ($P < .05$). The latter had more DM (44.2 vs 38.7%), CP (5.9 vs 5.1%), and organic matter (39.7 vs 34.0%) than LC ($P < .05$). There was a trend (61.9 vs 58.9%) for HC to have higher *in vitro* DM digestibility ($P < .07$). In this trial the increase in nutritive value as a result of a higher cutting height did not offset the decrease in total digestible nutrients harvested. Possible reasons could be the variety and stage of maturity at harvesting. Nevertheless adjusting cutting height could be a useful strategy when energy dense rations have to be formulated in the presence of high grain prices.

Key Words: Corn silage, Harvesting height

1132 Yield, chemical composition and ruminal degradability of *Brachiaria humidicola* (Rendle) Schweick at seven clipping stages under dry tropical conditions. J. Vergara-Lopez* and O. Araujo-Febres, La Universidad del Zulia, Facultad de Agronomía. Maracaibo, ZU 4005. Venezuela. *jvergara.luz.ve.*

Plots of *Brachiaria humidicola* were clipped at 14, 28, 42, 56, 70, 84 and 98 days to assess yield, chemical composition and ruminal degradability during dry (DS) and rainy season (RS). Dry matter (DM), organic matter (OM), crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and lignin (Lig) were determined on field samples. Degradability of DM and CP were evaluated utilizing two steers with permanent rumen canulae. Three mathematical models were evaluated: first order kinetics (FOK), FOK with discrete lag phase (FOL) and sigmoidal (SIG). Yield increased ($P < .05$) from 1099.3 kg ha⁻¹ clipping⁻¹ (14d) to 2654.0 kg ha⁻¹ clipping⁻¹ (98d) and from 1547.1 kg ha⁻¹ clipping⁻¹ (14d) to 3092.7 kg ha⁻¹ clipping⁻¹ (98d) on DS and RS respectively. DM increased ($P < .05$) from 41.1% (14d) to 47.7% (98d) during DS and from 35.7% (14d) to 43.0% (98d) during RS. OM remains constant along ages during DS (89.0%), while during RS it increased ($P < .05$) from 84.7% (14d) to 90.3% (98d). CP decreased ($P < .05$) from 6.6% (14d) to 4.8% (98d) and from 8.5 (14d) to 4.3% (98d) during DS and RS respectively. NDF remains constant along ages (70.6% and 76.0% for DS and RS, respectively). ADF during RS (37.9%) was higher ($P < .05$) than DS (40.5%). Lig remains constant along DS (4.38%), while in RS it increased from 5.0% (14d) to 6.3% (98d). DM degradability was affected by season and mathematical models estimation: 77.6% and 80.4% for FOK, 44.7% and 42.0% for FOL and 75.2% and 78.1% for SIG during DS and RS, respectively but not by ages. CP degradability had a similar performance: 63.8% and 65.5% for FOK, 51.0% and 63.9% for FOL and 61.9% and 63.7% for SIG during DS and RS, respectively. Season affected yield, OM, CP, FDA, Lig and DM and CP degradability. We recommend to use SIG to evaluate ruminal degradability.

Key Words: *Brachiaria humidicola*, dry matter yield, rumen degradability

1133 Effects of corn silage or high moisture corn supplementation on performance of beef heifers grazing high quality pastures. L. O. Abdelhadi*^{1,2}, F. J. Santini¹, G. A. Gagliostro¹, and C. A. Cangiano, ¹Fac. Cs. Agrarias. UNMdP-INTA EEA Balcarce, ²CONICET.

The objective of the experiment was to evaluate if replacing high quality fresh pasture with corn silage (CS) or high moisture corn (HMC) could affect liveweight gain (LWG) and fat deposition rate (FDR). Forty-eight British heifers averaging 10 months of age and 196 kg of liveweight (LW) at the start of the experiment were assigned to three treatments in a randomized design. In T0 fresh pasture was the sole component of the diet; in T1 CS was included at 40% of the diet and in T2 HMC was included at 31% of the diet (on a DM basis). All heifers grazed in a one-day strips throughout 81 days from August to October, a mixed pasture containing 80% grass and 20% legume. Herbage mass averaged 3416±838 kg DM/ha and parameters of pasture quality were: DM 30±1.6%; CP 12.6±2.4%, NDF 46.6±3.8%; IVOMD 69.9±3.3% and a soluble carbohydrate content of 18.1±3.4%. Supplements contained 6.9 and 10% CP; 45.7 and 9.8% NDF; 21.5 and 64.5% starch; 61.7 and 87.2% IVOMD and were consumed at a rate of 2.9±0.4 (1.06% of LW) and 2.7 (1% of

LW) kg DM/animal/day, for CS and HMC respectively. Total DM intake (DMI) was estimated in eight heifers per treatment using Cr₂O₃ as a fecal marker. FDR was estimated measuring fat cover (FC) between 11-12th rib using an ultrasonic ecograph. Jugular blood samples were obtained to measure glucose and urea concentrations. Supplementation of high quality pasture with CS or HMC, allowed to increase stocking rates from 4.2 in T0 up to 7 (T1) and 6.2 (T2) heifers/ha and beef production from 320 in T0 up to 499 (T1) and 467 (T2) kg/ha, without decreasing LWG and FDR of the animals.

Item	T0	T1	T2	SEM
DMI, kg/d	7.24 ^b	6.68 ^b	8.54 ^a	0.25
Initial LW, kg	198.6	198.9	188.7	3.85
Final LW, kg	277.2	268.7	264.1	4.05
LWG, kg/d	0.94	0.88	0.93	0.03
Initial FC, mm	2.52	2.22	2.23	0.12
Final FC, mm	4.05	4.23	3.67	0.25
FDR, mm/30d	0.75	1.05	0.60	0.30
Glucose, mg/dl	51.9 ^c	77.2 ^a	62.1 ^b	0.02
Urea, mg/dl	29.7	23.9	17.1	0.04

^{abc}Means within a row with unlike superscripts differ ($P < 0.01$)

Key Words: Grazing Beef Heifers, Corn Silage, High Moisture Corn

1134 Effects of corn silage or high moisture corn supplementation on ruminal pH and pasture digestion in beef heifers grazing high quality pastures. L. O. Abdelhadi*^{1,2}, F. J. Santini¹, C. A. Cangiano¹, and G. A. Gagliostro¹, ¹Fac. Cs. Agrarias. UNMdP-INTA EEA Balcarce, ²CONICET.

Six British heifers ruminally cannulated, averaging 284±25 kg of live weight (LW), were used in a replicated 3 x 3 Latin square with 15 day-periods to study the effect of corn silage (CS) or high moisture corn (HMC) supplementation on ruminal pH and *in situ* pasture digestion characteristics. Heifers were fed diets consisting of fresh pasture as the sole component (T0); CS was included at 40% of the diet in T1 and HMC was included at 31% of the diet in T2 (on a DM basis). All heifers grazed in a one-day strips from August to October, a mixed pasture containing 80% grass and 20% legume. Herbage mass averaged 3416±838 kg DM/ha and parameters of pasture quality were: DM 30±1.6%; CP 12.6±2.4% NDF 46.6±3.8%; IVOMD 69.9±3.3% and a soluble carbohydrate content of 18.1±3.4%. Supplements contained 6.9 and 10% CP; 45.7 and 9.8% NDF; 21.5 and 64.5% starch; 61.7 and 87.2% IVOMD and were fed once (7h) or twice daily (7 and 16h) before heifers returned to pasture, for CS and HMC respectively. Heifers consuming diets containing CS had higher ruminal pH ($P < 0.05$). Pasture degradation characteristics were estimated using the model of Orskov and Mc Donald (1979). CS increased potentially digestible fractions (PD) of pasture DM and NDF ($P < 0.05$); while HMC decreased degradation rate, PD and effective degradability (ED) of pasture NDF ($P < 0.05$). Neither degradation rate nor ED of pasture DM was different among treatments ($P > 0.05$). These results suggest that CS supplementation had a positive associative effect on high quality pasture digestion, being a more appropriate supplement than HMC to be used in grazing beef heifers.

Item	T0	T1	T2	SEM	P <
pH	5.9 ^b	6.3 ^a	5.8 ^b	0.08	0.01
DM					
PD, %	79.1 ^b	84.4 ^a	79.3 ^b	1.39	0.05
Rate, %/h	8.1	7.0	8.8	0.89	0.39
NDF					
PD, %	79.5 ^b	84.8 ^a	70.9 ^c	0.91	0.01
Rate, %/h	3.9 ^a	4.4 ^a	2.8 ^b	0.28	0.01
ED (kp ¹ =5%/h)					
DM	64.7	67.6	66.7	1.04	0.19
NDF	53.1 ^b	59.1 ^a	46.2 ^c	1.41	0.01

¹rate of passage assumed

Key Words: Grazing Beef Heifers, Corn Silage, High Moisture Corn

1135 Rumen fermentation patterns of a range of forage diets. V. E. Brown* and R. E. Agnew, *Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down.*

9 rumen fistulated steers, averaging 750 kg, were used to evaluate the rumen fermentation characteristics of 24 forage treatments, consisting of sole forages and forage mixtures. Treatments were formulated on two basic parameters (1) to reflect diets in commercial use and (2) to give a large range of rumen fermentation patterns. 12 forages were used as the basis for the 24 treatments: grass, high dry matter silage, low dry matter silage, high digestibility silage, low digestibility silage, maize silage, whole crop wheat, hay, straw, lucerne, fodder beet and potatoes. Each treatment was fed to maintenance energy level, in a changeover design to allow 3 replications of each treatment. Periods were 16 days in length, days 1-14 for dietary acclimatisation and rumen sampling on days 15-16. The animals were fed twice daily, with equal portions given at each feed (9am and 4pm). Samples of rumen fluid were obtained through a rumen cannula, using an aspiration method, at 1, 2, 4 and 6 hours after the morning feed, and 1, 2, 4, 7, 11, 14 and 16 hours after the evening feed. The data were analysed using Genstat REML procedure for the analysis of variance of unbalanced data. The model removed animal and period effects, and compared treatment means using the between animal variation. The time means were compared using within animal variation. There were significant effects of treatment on rumen ammonia, propionate, butyrate, valerate, ethanol, proportion of acetate, proportion of butyrate, proportion of valerate and acetate: propionate ratio. Time had a highly significant ($p < 0.01$) effect on all rumen parameters measured, and treatment by time interactions were also highly significant with all treatments. A model to predict rumen fermentation parameters from feed characteristics has been developed.

Key Words: Rumen Fermentation, Forage diets

1136 Ruminal parameters and digestibility in sheep fed with basal oat straw diet. H. G. González*¹, O. B. Ruiz¹, M. L. De la Vega¹, A. Correa², F. J. Verdugo², H. C. Hernández³, L. E. Gerlach⁴, A. E. Orozco¹, and E. E. Perez⁵, ¹Universidad Autónoma de Chihuahua, ²Universidad Autónoma de Baja California, ³Universidad Autónoma de Baja California Sur, ⁴Universidad de Sonora, ⁵Universidad Autónoma de Ciudad Juárez, Mexico.

Eight crossbred sheep with permanent ruminal cannulated were used in a fed trial. The objective was to evaluate the effect of two size ground length: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and digestibility. The animals were fed by using a basal oat straw diet and providing them an alfalfa hay supplement (20 %), all diets were isonitrogenous. Rumen fluid samples were collected at 0h, 1.5h, 3h, 6h, 9h, 12h, 16h and 24 hours after first meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acids (VFA) concentration. The digestibility (DM, ADF and NDF) was estimated through the total collection of feces and measurement of feed intake. The ruminal degradation of straw was estimated by using the nylon bag technique under a non linear model. The statistical analysis of data was made by using a crossover design. The feed intake was *ad libitum*. It was observed a bigger dry matter intake ($P < .07$) of T1 than T2 (56.8 vs 50.4 g kg⁻¹ W^{.75}). There was not found significant differences ($P > .05$) to pH (7 vs 6.9), NH₃-N (12.5 vs 12.8 mg 100 ml⁻¹) and isobutyric acid (.8 vs .6 mM). However there were detected significant differences ($P < .01$) between T1 and T2 in concentration of acetic (78.6 vs 83.7 mM), propionic (15.5 vs 11.5 mM) and butyric ($P < .05$; 5.1 vs 4.2 mM), respectively. There was detected significant differences ($P < .07$) in DM digestibility (55.9 vs 58.7 %), ADF (54.8 vs 55.5 %) and NDF (56.3 vs 58.2 %) of diets T1 and T2, respectively. It was detected significant difference ($P < .06$) into the potential degradation of constant b (42.7 vs 44.6 %), but no differences ($P > .05$) were detected into degradation rate (2.6 vs 2.4 % h⁻¹) between T1 and T2. These results suggest that size of the forage affects the consumption and diet digestibility; there is an apparent effect into the ruminal conditions.

Key Words: Sheep, Particle size, Straw

1137 Ruminal parameters and digestibility in steers fed with basal oat straw diet. H. G. González*¹, O. B. Ruiz¹, M. L. De la Vega¹, A. E. Orozco¹, A. Correa², A. P. Márquez², L. E. Gerlach³, E. E. Perez⁴, and H. C. Hernandez⁵, ¹Universidad Autónoma de Chihuahua, ²Universidad Autónoma de Baja California, ³Universidad de Sonora, ⁴Universidad Autónoma de Ciudad Juárez, ⁵Universidad Autónoma de Baja California Sur, Mexico.

Four Hereford steers with permanent ruminal cannulated were used in a fed trial. The objective was to evaluate the effect of two size ground length: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and digestibility. The animals were fed by using a basal oat straw diet and providing them an alfalfa hay supplement (20 %), all diets were isonitrogenous. Rumen fluid samples were collected at 0h, 1.5h, 3h, 6h, 9h, 12h, 16h and 24 hours after first meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acids (VFA) concentration. The digestibility (DM, ADF and NDF) was estimated through the total collection of feces and measurement of feed intake. The ruminal degradation of straw was estimated by using the nylon bag technique under a non linear model. The statistical analysis of data was made by using a switch back design. The feed intake was *ad libitum*. It was observed a bigger dry matter intake ($P < .05$) of T1 than T2 (79.7 vs 70.8 g kg⁻¹ W^{.75}). The findings were not statistically different ($P > .05$) nor to pH (7 vs 7), NH₃-N (8.5 vs 8.7 mg 100 ml⁻¹) neither for VFA (acetic; 80.7 vs 80.9 mM), (propionic; 13.2 vs 13.3 mM), (butyric; 5.4 vs 5.2 mM), (isobutyric; .75 vs .65 mM) for T1 and T2 treatments, respectively. Nevertheless were detected significant differences ($P < .01$) in digestibility of DM (68.8 vs 71.5 %), ADF (66.9 vs 69.6 %) and NDF (68.2 vs 71.1 %) to diets T1 and T2, in that order. Additionally was detected significant difference ($P < .05$) into potential degradability of b constant (31 vs 33.3 %), the degradability rate (2.6 vs 2.6 % h⁻¹) was not statistically different ($P > .05$) for T1 and T2, respectively. The size of forage particle affected the consumption and the digestibility of the diet, apparently the rumen conditions did not.

Key Words: Steers, Particle size, Straw

1138 Digestibility in steers fed with a basal oat straw diet and supplemented with alfalfa. H. C. Hernandez*¹, M. L. De la Vega², M. G. Ferreira², A. P. Márquez³, A. Correa³, H. G. González³, and E. E. Perez⁴, ¹Universidad Autónoma de Baja California Sur, ²Universidad Autónoma de Chihuahua, ³Universidad Autónoma de Baja California, ⁴Universidad Autónoma de Ciudad Juárez, Mexico.

To evaluate the digestion performance, four Hereford steers 230 kg and permanent ruminal cannulated were fed to a basal oat straw diet and supplemented with alfalfa hay to levels (0, 10, 20 and 30 %) of dry matter intake and .5 kg rolled milo per animal d⁻¹, all diets were isonitrogenous. The digestibility (DM, ADF, NDF and cellulose) was estimated through the total collection of feces and measurement of feed intake. The data were analyzed by using a 4 x 4 latin square design. The voluntary intake of total diet (64.6, 69.8, 80.7 and 81.1 g kg⁻¹ W^{.75}) was improved ($P < .01$) proportional to an increase of supplements levels. There were detected significant linear trends ($P < .01$) to increase the digestibility proportional to an increase of supplement of alfalfa. Additionally, was detected significant differences ($P < .01$) into digestibility of DM (61.4, 61.2, 68 and 68 %), NDF (57, 65.7, 65.3 and 64.6 %), ADF (54.4, 57.3, 62.3 and 62.4 %) and cellulose (62.4, 63.3, 66.8 and 65.4 %) to supplemented alfalfa diets (0, 10, 20 and 30 %), in that order, best results were observed by using levels of 20 and 30 % of supplemented alfalfa. These findings suggest that the supplementation of a basal straw diet with alfalfa increase the total consumption and digestibility of fiber components of the total diet.

Key Words: Steers, Digestibility, Straw

1139 *In vivo* and *in vitro* digestibility and chemical composition of maize silage from a crop in three stages of maturity. M. Nomdedeu*^{1,2} and O. N. Di Marco¹, ¹Fac. Cs. Agrarias UNMDP-INTA EEA Balcarce, ²CIC, Mexico.

The objective of this experiment was to investigate the effect of a maize crop maturity on silage *in vivo* digestibility of dry matter (IDMD) and neutral detergent fiber (INDFD) and the relationship of these parameters with their corresponding *in vitro* determinations (IVDMD) and (IVNDFD). The crop was harvested at the following maturity stages:

a) stage-blister (20.5% DM), b) stage-milk (26.0% DM) and c) stage-dough (32.5% DM). *In vivo* digestibility was measured using 9 lambs (30 kg BW) in a triplicate 3x3 latin squared design with 17 days-periods. The silages were characterized in terms of their contents of NDF, ADF, starch (STA), soluble non structural carbohydrate (SNSC) and lignin (L). As the maturity of the crop progressed the content of STA in the silage increased from 2.0% to 27.5% and the NDF decreased from 60.4% to 42.0% ($P < 0.05$), but L remained constant ($P > 0.05$). The IDMD was not affected ($P > 0.05$) by the stage of growth of the crop (average: 52.4%), the starch was completely digested *in vivo*, although INDFD decreased from 52.5% to 29.0% ($P < 0.05$). The IVDMD (average: 60.7%) was 8 points higher than IDMD and increased ($P < 0.05$) at 62.5% in the latest stage of growth. The IVNDFD was lower than INDFD but both were correlated ($r: 0.99$). It was concluded that the changes provoked by crop maturity affected silage INDFD without affecting IDMD, which was over predicted by 15% by the *in vitro* digestibility.

Parameters (%)	Stage-blister	Stage-milk	Stage-dough	SEM
STA	2.0 ^a	13.4 ^b	27.5 ^c	0.242
ADF	35.6 ^a	31.4 ^b	26.2 ^c	0.506
NDF	60.4 ^a	55.6 ^b	42.0 ^c	0.264
L	3.3 ^a	3.2 ^a	2.6 ^a	0.165
SNSC	2.3 ^a	9.7 ^b	9.0 ^c	0.020
IDMD	52.2 ^a	52.3 ^a	52.6 ^a	0.010
INDFD	52.5 ^a	45.6 ^b	29 ^c	0.928
IVDMD	59.2 ^a	60.0 ^a	62.5 ^b	0.377
IVNDFD	43.9 ^a	34.3 ^b	19.2 ^c	0.667

^{abc}Means within a row with the same letter are not different (Tukey, $P > 0.05$)

Key Words: Whole-plant Corn Silage, Digestibility, Maturity Stage

1140 Corn silage supplementation of different chop length to dairy cows grazing temperate pasture. G.A. Pieroni*, D.H. Rearte, F.J. Santini, M. San Martín, and G. Eyherabide, *Fac. Cs. Agrarias, UNMdP - EEA INTA Balcarce, Bs. As., Argentina.*

The objective of the trial was to evaluate the effects of corn silage supplementation of different particle length on total intake, milk yield and composition, BW and BCS of grazing dairy cows. Whole-plant corn (2/3 milkline) was harvested and chopped at 6mm (CS6) or 24mm (CS24) without rolling. Forty Holstein cows (48 DIM, 581 kg BW and 2.15 BCS) were randomly assigned to two treatments: 1) 6 kg DM/d CS6 (CS6), and 2) 6 kg CS24 (CS24). Corn silage (plus 0.06 kg/cow/d urea) was fed twice daily after milking. CS6 and CS24 had 32.4 and 30.3% DM; 7.6 and 8.3% CP; 36.5 and 42.9% NDF; 65.0 and 63.4% *in vitro* DM digestibility (IVDMD), respectively. Cows grazed a winter oats (*Avena sativa* L.) pasture offered at 27.3 kg DM/cow/d with in average 1690 kg DM/ha herbage mass, 17.6% DM; 18.4% CP; 34.8% NDF; and 77.2% IVDMD. Cows were allotted to a new paddock twice daily, after corn silage feeding. Both groups of cows were fed with 5.5 kg DM/d of a 65% ground corn-35% sunflower meal concentrate with 89.3% DM; 20.2% CP; 23.3% NDF; and 75.4% IVDMD. Intake of total DM (estimated on six cows per treatment using Cr₂O₃ as a fecal marker), corn silage, concentrate, and pasture were similar between treatments ($P > 0.10$) (average 20.96; 5.45; 5.23 and 10.28 kg/d, respectively). Milk yield and composition were analyzed by repeated measurement (10 weeks). Not interaction between treatments and weeks were detected ($P > 0.10$). Milk yield and composition were not affected by treatments ($P > 0.10$). Neither BW nor BCS change were different between treatments ($P > 0.10$). Chopped length (6 or 24 mm) of corn silage supplemented to dairy cows grazing high quality pasture did not affect performance.

	CS6	CS24	SEM	$P >$
Milk yield, kg/d	23.41	23.55	0.54	0.86
FCM 4%, kg/d	22.01	22.10	0.60	0.91
Protein, %	3.49	3.45	0.03	0.36
Protein yield, kg/d	0.813	0.802	0.02	0.71
Fat, %	3.57	3.66	0.07	0.39
Fat yield, kg/d	0.838	0.848	0.03	0.77

Key Words: Corn Silage, Chop Length, Grazing Dairy Cows

1141 Effect of particle size, quality and quantity of alfalfa hay, and cow on selective consumption by dairy cattle.. C. Leonardi* and L. E. Armentano, *University of Wisconsin, Madison.*

Twenty-four lactating Holsteins (half primiparous) were used in 4 6x6 Latin Squares. The experimental periods were 7 d each. Cows were in tie-stalls; diets were fed at libitum twice a day at 1100 and 1600. Diets contained 60% concentrate and 40% alfalfa, with either 20% hay and 20% haylage or 40% hay (DM basis). Treatments were: 20% of low quality chopped hay (20LQC) or high quality chopped hay (20HQC), 20% low or high quality long alfalfa hay (20LQL or 20HQL), or 40% low or high quality chopped alfalfa hay (40LQC or 40HQC). Particle distribution of TMR and refused feed were determined using square hole screens with diagonals: 26.9, 18, 8.98, 5.61 and 1.65 mm (Y1 to Y5 respectively). The intake of each fraction was expressed as % of the theoretical intake, where theoretical intake of Y_n = as fed intake × fraction of Y_n in TMR. No differences were observed in sorting behavior between day 1 and the end of the periods, data presented are from the end of the periods. Across treatments, animals consistently sort against long particles (Y1 and Y2 <100%). Increasing the proportion of dry hay dramatically enhanced sorting. Surprisingly there was significantly less sorting for the lower quality hay. A primary goal of this trial was to measure variation among cows. Intake of Y1 (averaged across the 6 treatments for each cow) was between 60 and 70% for 4 cows, 70-80% for 11 cows, 80-90% for 5 cows, 90-100% for 2 cows and 100-110% for 2 cows. Sorting by a single cow can be quite extreme as exhibited by one cow fed 40LQC who consumed no Y1 particles.

	20 HQL (A)	20 LQL (B)	20 HQC (C)	20 LQC (D)	40 HQC (E)	40 LQC (F)	C,D vs E,F	A,C,E vs B,D,F	A,B vs C,D
DMI, kg/d	23.9	23.7	24.2	24.4	25.8	25.7	$P < .01$	$P = .92$	$P = .14$
Y1, %	86.7	86	86.7	96.3	56.4	63.8	$P < .01$	$P < .05$	$P = .06$
Y2, %	94.3	93.1	95.3	90.4	82.8	79.9	$P < .01$	$P < .05$	$P = .05$
Y3, %	96.7	96.2	96.9	95.5	84.2	84.8	$P < .01$	$P = .8$	$P = .65$
Y4, %	99.9	99.2	99.5	99.9	99.5	101.9	$P < .05$	$P = .07$	$P = .82$
Y5, %	103.7	103.6	102.3	101.8	107.6	107.2	$P < .01$	$P = .42$	$P < .01$
PAN, %	105.8	106.4	104.1	104.3	111.2	110.2	$P < .01$	$P = .94$	$P < .05$

Key Words: Particle size, Alfalfa hay, Sorting

1142 The effect of processing corn silage prior to ensiling on particle size and production and digestibility characteristics of growing beef heifers. D.R. ZoBell*¹, K.C. Olson¹, R.D. Wiedmeier¹, D. Sass², K.J. Shinnors³, and T.A. McAllister⁴, ¹Utah State University, ²Pioneer Hi-Bred, ³University of Wisconsin, ⁴Agriculture and Agri-Food Canada.

A study was conducted to determine the effect of processing corn silage, prior to ensiling, on particle size, feedlot production, and *in vivo* digestibility characteristics of growing beef heifers. Corn was planted in the spring and in the fall, chopped, and ensiled. Two identical six-row self-propelled choppers were utilized, one of which was adapted with a roller-processing unit. The chopped corn was taken from the same field and ensiled in a silage bag. Over the 56 day feedlot study, heifers (293 kg initial weight) were randomly assigned one of two treatments: unprocessed (UP) or processed (P). The growing ration consisted of 55.4% UP or P corn silage, 22.3% alfalfa hay, 19.6% wheat mill run, and 2.7% supplement (DMB). There were 15 head per pen with three replications per treatment. The *in vivo* digestibility study consisted of four cannulated beef heifers in a double cross-over design with a three week adaptation and six day collection period using the same grower ration as the feedlot study. Whole-plant particle size was quantified from three separate sub-samples per treatment using standard procedures. Results showed that whole cob fraction as a percent of total mass were 0 and 6.5 ($P < .05$) for the P and UP respectively. Undamaged kernels and broken kernels as a percent of total kernel mass were 1.8% and 93.9% for P and 17.3% and 64.5% for UP ($P < .05$). Average daily gain (kg-ADG), dry matter intake (kg-DMI), and feed efficiency (FE) for the 0-56 day period were .96, 7.55, and 7.87 for UP and 1.00, 7.59, and 7.56 for the P heifers with no differences for any of these traits ($P > .05$). *In vivo* digestibility measurements showed that pH, volatile fatty acids, dry matter, acid detergent fiber, and neutral detergent fiber digestibilities were not affected by treatment. ($P > .05$). This study shows that corn silage kernels are affected by processing and there is a numerical trend for improved ADG and FE.

Key Words: Corn silage, Processing silage, Heifers

1143 Effect of feeding a corn hybrid selected for leafiness as silage or grain to lactating dairy cattle. P.W. Clark*¹, S.C. Kelm¹, and M.I. Endres², ¹University of Wisconsin, River Falls, ²Mycogen Seeds.

Sixteen multiparous Holstein cows were used in a feeding trial based on 4 x 4 Latin squares with 21 d periods to evaluate a leafy corn hybrid as both a silage and grain crop for lactating cows. Four diets containing (dry basis) 8% chopped hay, 42% corn silage, 11% high moisture corn grain, 10% whole, fuzzy cottonseed, and 29% concentrate varied only in the variety of corn (leafy = L or control, grain-type hybrid = C) used for grain (G) or silage (S). Cows on the L silage diets (LGLS and CGLS) produced more ($P < .05$) milk (43.2 vs. 41.8 kg/d), 4% FCM (38.5 vs. 37.2 kg) and protein (1.38 vs. 1.33 kg/d) and ate more DM (23.3 vs. 22.4 kg/d) than cows on the C silage diets (LGCS and CGCS). There was no difference ($P > .05$) in milk protein or fat concentration. Grain variety (LGLS and LGCS vs. CGLS and CGCS) did not influence ($P > .05$) milk yield or composition. Dry matter intake was greater ($P < .05$) for the "all leafy" diet (LGLS) compared to the "all control" diet (CGCS) at 23.5 vs. 21.9 kg/d. In this study, cows fed leafy corn silage consumed more DM and produced more milk and protein than cows fed the control, grain-type corn silage.

Key Words: Corn Silage, Dry Matter Intake

1144 Effect of feeding Roundup Ready[®] corn silage and grain on feed intake, milk production and milk composition in lactating dairy cattle. S. S. Donkin*¹, J.C. Velez¹, E. P. Stanisiewski², and G. F. Hartnell², ¹Purdue University, West Lafayette, IN, ²Monsanto Company, St Louis, MO.

Dairy cows were used to determine the effects of feeding corn, genetically modified to tolerate glyphosate, on feed intake, milk production and milk composition. Alternating plots of a 20.25 ha field were planted at equal densities with either Roundup Ready[®] (RR) corn (DK626RR) or its isogenic (ISO) counterpart (DK626). Perimeter rows were removed and half of each strip was harvested for whole plant corn silage. The remainder was allowed to mature and was harvested as grain. Sixteen multiparous Holsteins (71 to 107 DIM) were assigned to two groups and fed diets containing 62% corn silage and 17% corn grain (DM basis) from either RR or ISO lines; the balance of the diet was protein supplements, vitamins and minerals. Diets were formulated to contain 1.64 Mcal/kg NEL, 16.7% CP, 16% ADF, 27% NDF, 0.65% Ca and 0.43% P. Treatments were applied as switchback design consisting of 3 contiguous 28-d periods with each period containing 14-d of adaptation followed by 14 days of data collection. Cows were fed for ad libitum intake and milked twice daily. There were no significant differences for dry matter intake, 21.5 vs. 21.9 ± 0.4; milk production, 29.4 vs. 29.5 ± 0.4; milk protein yield, 0.96 vs. 0.96 ± 0.01; milkfat yield, 1.04 vs. 1.06 ± 0.02; or lactose yield, 1.39 vs. 1.40 ± 0.22 (kg/d) between RR and ISO diets, respectively. There were no differences in percentages of milkfat, 3.55 vs. 3.61 ± 0.04; protein, 3.25 vs. 3.25 ± 0.02; lactose, 4.70 vs. 4.72 ± 0.01; solids not fat, 8.74 vs. 8.75 ± 0.02; SSC (1000/ml), 100 vs. 98 ± 10; or MUN (mg/dl), 10.9 vs. 10.8 ± 0.2 between RR and ISO diets. There were no differences in 4% FCM yield to DM intake (kg/kg), 1.29 vs. 1.30 ± 0.02 between RR and ISO diets, respectively. The data demonstrate lactating cows fed RR corn and the ISO counterpart perform similarly.

Key Words: Genetically modified crops, Milk production, Roundup Ready[®]

1145 Effects of corn silage hybrid and level of forage NDF on nutrient digestibility and duodenal fatty acid content of lactating cows. X. Qiu*, M.L. Eastridge, and Z. Wang, The Ohio State University, Columbus.

Four ruminally and duodenally cannulated primiparous cows were fed four diets in a 4 x 4 Latin square design: 1) 17% forage NDF (FNDF) with brown midrib (BMR) corn silage (CS), 2) 21% FNDF with BMR CS, 3) 17% FNDF with conventional CS (CCS), and 4) 21% FNDF with CCS. Diets contained 17.3% CP and 38.5% NDF. Each period consisted of 2 wk with the later weeks devoted to data collection. Duodenal, fecal, and ruminal bacteria samples were collected from day 11 through 13 to determine nutrient digestibility, efficiency of bacterial N synthesis, and duodenal content of fatty acids (FA). Ruminal fermentation characteristics and production responses have been previously reported (J. Dairy Sci. 82 (Suppl.1):88). Intakes of DM, OM, NDF, protein, starch,

and FA were higher or tended to be higher for BMR CS than CCS and for 17% FNDF than 21% FNDF. The total tract digestibilities of these components and efficiency of bacterial N synthesis were similar among treatments, except that BMR CS resulted in lower intestinal FA digestibility (74.1 vs. 78.8% of duodenal flow) than CCS, and 17% FNDF tended to be higher in total tract FA digestibility (79.7 vs. 76.5%) than 21% FNDF. Ruminal NDF digestibility was similar among dietary treatments (54.7, 54.8, 52.6, and 46.5%). Compared with CCS, BMR CS tended to be higher in duodenal content and flow of oleic acid (4.64 vs. 4.48 mg/g DM; 50.3 vs. 44.6 g/d), linoleic acid (2.22 vs. 1.97 mg/g DM; 24.6 vs. 19.8 g/d), and conjugated linoleic acid (CLA; 0.17 vs. 0.15 mg/g DM; 1775.8 vs. 1490.3 mg/d). There tended to be an interaction between CS and FNDF on biohydrogenation (71.5, 74.7, 77.0, and 74.2%, respectively). Based on the data from this study, the increased milk production observed from feeding BMR CS in some studies may be explained by higher DM intake rather than an increased total tract digestibility of the diets. Feeding the BMR CS tended to increase duodenal flow of CLA, which should translate to increased availability of CLA for transfer into milk fat.

Key Words: Brown Midrib, Corn Silage, Conjugated Linoleic Acid

1146 Feeding value of whole plant silage and crop residues from Bt or normal corns. K.S. Hendrix*, A.T. Petty, and D.L. Lofgren, Purdue University, West Lafayette, IN.

During the 1998 (yr 1) and 1999 (yr 2) cropping seasons, 6.8 ha fields were planted to either a Bt or the isogenetic normal (N) corn hybrid. Objectives were to determine the influence of corn type on: 1) performance of steer calves fed whole plant silage (WPS), 2) performance of beef cows grazing corn residue and 3) grazing pattern of beef cows when given a choice of either Bt or N residue. Each yr, 56 Angus and Simmental sired steer calves (299 kg) were randomly allotted by weight and breed type into eight pens of seven steers. Four pens were fed diets containing WPS from either corn type for 89 d (yr 1) and 85 d (yr 2). Dry, pregnant beef cows (40 in yr 1, 36 in yr 2) were randomly allotted by weight and body condition score into four groups. Replicate groups grazed either Bt or N corn residue (6.8 ha/group) for 34 d (yr 1) and 42 d (yr 2). In yr 1, 20 additional cows were given access to adjacent fields from which the division fence was removed. One field contained residue from Bt corn and the other residue from N corn. Three times daily, the number of cows within each field was observed. For steer calves, the interactions among corn type, breed type and year were not significant ($P > .10$) for ADG, daily DMI or feed/gain. ADG (1.30 vs 1.34 kg/d) and DMI (8.88 vs 8.67 kg/d) for steers fed Bt vs N silage, respectively, were not different ($P > .10$). However, feed/gain was greater (6.86 vs 6.48, $P < .05$) for steers fed Bt vs N WPS. For cows grazing residue, the interaction of year and corn type was not significant ($P > .10$). Average weight change was -2.29 vs -2.34 kg/cow for Bt vs N residue ($P > .10$), respectively. When given a choice of grazing Bt or N corn residue, cows tended to graze as a group and grazing pattern varied greatly. Over the entire observation period, 46% of cows were observed in the Bt field vs 54% in the N field ($P < .01$). These results do not indicate major differences in the feeding value of WPS or residue between Bt and N corns. A slight reduction in energy level of Bt WPS is indicated based on steer calf performance.

Key Words: Beef, Bt Corn

1147 Effects of activated carbon on performance and apparent total tract nutrient digestibility of dairy cows fed poorly fermented corn silage. P.S. Erickson*¹, N.L. Whitehouse¹, O.A. Ayangbile², D.A. Spangler², A. Gotlieb³, and C.G. Schwab¹, ¹University of New Hampshire, Durham, ²Agri-King Inc., Fulton, IL, ³University of Vermont, Burlington.

Activated carbon (AC) is a widely used toxin binder in non-agricultural industries. The primary objective of this study was to determine the effects of adding AC to a diet containing mycotoxin-laden corn silage on DMI and total tract nutrient digestibility. Six multiparous late lactation Holstein cows (738 kg BW) were assigned to a replicated 3 X 3 Latin square design; period length was 21d with the last 10 d for data collection. Diets contained 60 % corn silage, 30 % dry ground corn, 6.0 % soybean meal, and 4.1 % minerals and vitamins (DM basis). Treatments were 0 g/d, 20 g/d or 40 g/d AC and were topdressed onto the TMR once daily and hand mixed. Cows were dosed with 10 g Cr₂O₃ twice daily during the collection period. Deoxynivalenol was measured in the

corn silage and varied from 0.8 ppm to 1.5 ppm over the experiment. Milk samples (AM and PM) were taken on d 16 and d 21. A trend ($P < .10$) for linear increases in DMI (0 g, 17.5 kg; 20 g, 18.7 kg; 40 g, 19.8 kg) and apparent N digestibility (0 g, 58.4 %; 20 g, 61.0 %; 40 g, 62.1 %) occurred in cows fed AC. Apparent NDF digestibility, apparent hemicellulose digestibility (NDF % - ADF %) and body condition score were improved linearly ($P < .05$) by AC supplementation (0 g, 47.7 %, 57.2 %, 3.6; 20 g, 47.5 %, 57.2 %, 3.8; 40 g 51.9 %, 64.0 %, 4.0). There were no effects of AC on milk production or composition. Activated carbon improved DMI and apparent total tract fiber digestibility when cows were fed poorly fermented corn silage.

Key Words: Activated Carbon, Deoxynivalenol, Digestibility

1148 Effects of replacing concentrate with soyhulls in diets of lactating cows. I. R. Ipharraguerre*¹, R. R. Ipharraguerre², and J. H. Clark¹, ¹University of Illinois, Urbana, ²University of Buenos Aires, Argentina.

Soyhulls (SH), a by-product of soybean processing, can be used as a replacement of either grain or forage in dairy cattle diets because of their high content of fermentable fiber. This study was conducted to evaluate the substitution of SH for concentrate in the diet of mid-lactation Holstein cows. Fifteen multiparous cows averaging 112 DIM were used in a triplicated 5x5 Latin square with 21 day periods. Diets were isonitrogenous and consisted of 23% alfalfa silage, 23% corn silage, and 54% concentrate on DM basis. The pelleted SH replaced the concentrate to supply 0, 10, 20, 30, or 40% of the dietary DM. The five diets were fed twice daily as TMR to ad libitum intake. Dietary DM intake (DMI), milk yield, and milk composition were measured during the last week of each experimental period. DMI tended ($P < .06$) to linearly decrease and NDF intake linearly increased ($P < .0001$) as SH increased from 0 to 40% of dietary DM. Milk yield, protein content, protein yield, MUN, and total solids (TS) yield were not affected by treatments. However, increasing the dietary DM percentage of SH linearly increased milk fat content ($P < .004$), fat yield ($P < .001$) and TS concentration ($P < .007$). Therefore, SH represent an alternative feed for replacing a portion of the concentrate in the diet of mid-lactation cows without depressing the production of milk and milk components. Furthermore, feeding SH may help to reduce feed cost.

Item	SH, % of dietary DM					SEM	P
	0	10	20	30	40		
DMI, kg/d	23.8	24.8	24.4	22.9	22.7	.63	.06
NDF intake, kg/d	6.9	8.5	9.7	10.2	11.2	.30	.0001
CP intake, kg/d	3.7	3.9	3.8	3.6	3.7	.11	.57
Milk yield, kg/d	29.5	29.3	29.9	29.3	28.3	.48	.12
Fat, %	3.60	3.61	3.67	3.93	3.91	.09	.004
Fat, kg/d	0.99	1.00	1.06	1.11	1.08	.03	.001
Protein, %	3.36	3.28	3.33	3.30	3.31	.19	.36
Protein, kg/d	1.05	0.92	0.97	0.94	0.92	.07	.28
TS, %	12.36	12.41	12.56	12.76	12.67	1.30	.007
TS, kg/d	3.63	3.62	3.73	3.72	3.57	.11	.99
MUN, kg/d	14.0	14.4	14.4	14.5	14.4	.39	.41

Key Words: soyhulls, milk production, dairy cow

1149 Effect of urea molasses block storage time on intake and digestion of prairie hay by sheep. O. Araujo-Febres*, J. A. Vergara, M. B. Lachmann, and A. E. Ortega, La Universidad del Zulia. Facultad de Agronomía. Maracaibo, Venezuela.

A work was designed to measure the effect of storage time of supplemented urea molasses block (UMB) on intake, digestion and nitrogen balance in sheep fed with a low quality grass. Twelve male African hair sheep (aged 4 months; initial weight of 15 kg) were brought to metabolism crates for a 12-day adjustment period and 6-day experimental period. Animals were randomly assigned to one of the following treatments: (T1) Control, this group was offered a diet of 100% humidicola hay (*Brachiaria humidicola*) ad libitum; (T2) 15-days storage time UMB and hay; and (T3) 45-days storage time UMB and hay. Sheep received the supplements at 0900 and its had free access to water. All were drenched with an anthelmintic. During a 6 days trial period, animals were attached with harnesses for faecal collection, also refusals and urine outputs were collected. DM, OM and total nitrogen contents of

feed, feed refusals and faeces were determined. Urine samples were analysed for N. Digestibility and nitrogen balance were calculated for each group. All comparisons between treatments were analysed for a completely randomized design with 4 replications, using ANOVA of SAS. Nitrogen content of forage and supplements were .72 and 3.2%, respectively. Sheep supplemented any of UMB consumed more ($P < .05$) forage DM and OM than control. Forage DM and OM, and UMB intakes were similar among sheep fed different UMB. Increase in forage DM intake was 17% and 10% for T2 and T3, respectively. Supplementation with UMB increased ($P < .05$) digestible forage DM by 40%; digestible OM by 22%; and digestible N by 20%. Nitrogen apparently retained were 39.9%, 68.4% and 62.7% ($P < .01$) for T1, T2, and T3, respectively. The increase of both, intake and digestibility, indicate that UMB must have increase digestion more than enough to compensate for the increased passage rate. UMB increase intake and digestion of low-quality tropical forage.

Key Words: molasse urea block, digestion, intake

1150 Effect of substitution of alfalfa hay with clitoria hay (*Clitoria ternatea*) on apparent digestibility in sheep. A. Estrada*, R. Barajas, J.F. Obregon, and E. Sanchez, Universidad Autonoma de Sinaloa.

A cross over design experiment was conducted to determine the effect of substituting alfalfa hay with clitoria hay on total tract digestibility in sheep. Four Pelibuey male sheep (19.6 kg) allocated in metabolic cages (0.6 X 1.2 m), were assigned dietary treatments that consisted of: 1) Control: Alfalfa hay (CP, 18%; OM, 88.8%; and ADF, 41%); and 2) Diet similar to control, but substituting 50% of alfalfa hay with clitoria hay (CP, 18.5%; OM, 91%; and ADF, 43.5%). After a 10-day adaptation period, the total of produced feces were collected four four days. Food and fecal samples were oven dried (110 C; 24 h) and lab determinations for DM, OM, CP and ADF were performed. The substitution of 50% of alfalfa hay by clitoria hay, had no effect ($P > .10$) on daily intake of DM, OM, CP, or ADF. The treatments had no effect ($P > 0.10$) on total tract digestibility of DM (62.2 vs 63.3%), OM (63.4 vs 63.9%), CP (73.3 vs 74.3%), or ADF (53.3 vs 54.8%). Nutritional value of clitoria hay is similar to that of alfalfa hay.

Key Words: Alfalfa, Digestibility, Sheep

1151 Influence of feed intake and forage level on nutrient utilization in the rumen of sheep. I. Varhegyi, H. Febel*, and Sz. Huszar, Research Institute of Animal Breeding and Nutrition, Herceghalom, Hungary.

Ruminal fermentation and flow of microbial and dietary protein to the small intestine are affected by feed intake (FI) and the amount and source of energy and protein in the diet. Reports in which both FI and forage level (FL) were varied, are scarce. The goal of this study was to evaluate the effects of FI and different forage to concentrate ratios on rumen fermentation, microbial protein synthesis and degree of nutrient digestion in sheep. Four cannulated wethers were used in a 4x4 Latin square design experiment. Treatments consisted of HI-HF: high FI (65 g DM/kg BW^{0.75}/day) – high FL (70%), HI-LF: high FI – low FL (30%), LI-HF: low FI (40 g DM/kg BW^{0.75}/day) – high FL and LI-LF: low FI – low FL. The forage portion and concentrate components in the diets were altered by keeping the nonstructural carbohydrate:rumen degradable protein ratio constant (3.3). The pH of ruminal fluid was decreased and total VFA concentration was increased by higher FI and lower FL ($P < .05$). Regardless of FI, molar percentage of acetate was higher as forage proportion increased ($P < .05$). Molar percentage of propionate was the highest for wethers of HI-LF ($P < .05$). Ruminal ammonia and urea concentrations were decreased by higher FL ($P < .05$). Ruminal degradations of DM and OM were lower in the groups HI-HF and LI-HF ($P < .05$). At higher FI and with rations of higher FL, wethers had higher ($P < .05$) duodenal flows of total N and nonammonia N (NAN). This increase was due to an increase ($P < .05$) in both the quantity of microbial N and that of dietary N. Duodenal flows of microbial N and dietary N expressed as a percentage of NAN flow were similar ($P > .05$) regardless of the diet used. Efficiency of microbial protein synthesis was significantly higher ($P < .05$) when FL increased from 30% to 70% in the ration. This result suggests that, under the conditions of the recent study, diets with higher forage level (independent of feed intake), through more stabilized fermentation, caused degraded proteins to be transformed into microbial protein quite efficiently.

Key Words: Feed Intake, Forage Level, Sheep

1152 Effect of a fibrolytic enzyme supplement (Fibrozyme) on intake and apparent digestibility of alfalfa and ryegrass fed to lambs. R.J. Pinos¹, S. González¹, G. Mendoza¹, M. Cobo¹, R. Bárcena¹, A. Hernández¹, A. Martínez¹, M. Ortega¹, G. Hoyos², and K. Jacques*³, ¹*Colegio de Postgraduados, Montecillo, México*, ²*Alltech Mexico, Mexico City*, ³*Alltech Inc., Nicholasville*.

This study was conducted to evaluate effects of addition of a fibrolytic enzyme supplement (Fibrozyme, Alltech Inc.) to diets fed to lambs on feed intake and apparent digestion of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of alfalfa and ryegrass. Four ruminally cannulated lambs were randomly assigned to one of four dietary treatments in a 4 x 4 Latin square design, repeated in time, with a 2 x 2 factorial arrangement of treatments: two forages, alfalfa and ryegrass, and two levels of enzyme, 0 and 5 g/hd/day. Intake of alfalfa DM was higher than ryegrass DM intake ($P < 0.01$), while intake of alfalfa NDF was lower ($P < 0.01$). Intake of DM and NDF were increased ($P < 0.05$) by Fibrozyme for both the alfalfa and ryegrass diets ($P < 0.05$), however ADF intake was increased only in the ryegrass diet. Apparent digestibility of DM, OM, CP and NDF was higher ($P < 0.01$) for alfalfa than for ryegrass; but the enzyme did not affect digestibility of these fractions. Fibrozyme increased alfalfa NDF digestibility ($P < 0.10$). It was concluded that supplementation with Fibrozyme may affect intake and digestibility of forages with the presence or magnitude of the effect depending on forage type.

Key Words: Enzymes, Digestibility, Intake

1153 In vitro effects of common fatty acids on fermentation and protozoal numbers and activity in rumen fluid from cattle fed a barley-based diet. A. N. Hristov*¹, M. Ivan², and T.A. McAllister², ¹*Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330, U.S.A.*, ²*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1, Canada*.

Reducing protozoal density and activity in the rumen may be beneficial to the ruminant by reducing nitrogen recycling and increasing microbial nitrogen flow to the intestine. The objective of this experiment was to evaluate the effect of Na salts of fatty acids, commonly found in ruminant feeds on protozoal numbers and fermentation in vitro. Two 4-h incubations were carried out with rumen inoculum obtained from two heifers fed a diet consisting of (DM basis): 90% rolled barley grain; 4% barley silage; 5% soybean meal and 1% mineralized salt. The following FA were included individually in the incubation medium at three concentrations: C6:0, C8:0 and C10:0 (0.0625, 0.12, 0.25%); C12:0, C16:0, C18:1, C18:2 and C18:3 (0.25, 0.5, 1.0%); and C14:0 and C18:0 (0.125, 0.25, 0.5%). ¹⁵N-casein was added to the media as N tracer. With the exception of C6:0, C16:0, and C18:0 all FA reduced ($P < 0.05$) protozoal numbers to: 55% (C8:0), ND (not detected) (C10:0), ND (C12:0), 36% (C14:0), 6% (C18:3), 22% (C18:2), and 49% (C18:1) of the Blank (no FA addition, 1.78×10^6 protozoa per cm³, 99.6% *Entodinium* spp.). Compared to Blank, C8:0, C14:0, C18:3, C18:2 and C18:1 FA reduced ($P < 0.05$) protozoal activity (estimated as ¹⁵N-protozoa ÷ ¹⁵N-bacteria) by 81, 78, 54, 58 and 68%, respectively and C10:0 and C12:0 reduced ($P < 0.05$) total VFA concentration (by 29 and 22%, respectively). Compared to the Blank, C6:0, C8:0, C14:0, C18:3, C18:2 and C18:1 FA increased ($P < 0.05$) xylanase activity of the incubation media by 17, 46, 56, 52, 68 and 43%, respectively. These results suggest that FA such as C14:0, C18:3, C18:2 and C18:1 may have the potential to reduce protozoal numbers and activity without adversely affecting bacterial fermentation in the rumen of cattle fed high-grain diets.

Key Words: Fatty acids, Rumen Protozoa, Fermentation

1154 Immune response in feeder cattle fed different lipid sources. T.B. Farran*¹, J.S. Drouillard¹, M.F. Spire¹, D.A. Blasi¹, C.M. Coetzer¹, J.J. Sindt¹, H.J. LaBrune, S. B. Hogge¹, S.P. Montgomery¹, J.E. Minton¹, and T.H. Elsasser², ¹*Kansas State University, Manhattan*, ²*USDA, Agricultural Research Service, Beltsville, MD*.

Crossbred beef steers (n=20; 312 kg) were used in a completely randomized design to evaluate the effect of dietary lipid sources on response to endotoxin (LPS) challenge. Steers were fed diets containing rolled full-fat soybeans at 20% (SOY), or tallow at 3.85% (TAL) DM basis. Diets

were fed to steers in individual pens for 14 d. On d 14, steers (n=16) were injected intravenously with bacterial endotoxin (0.2 µg/kg BW *E. coli* 055:B5 lipopolysaccharide; Sigma Chemical Company, St. Louis, MO). Two steers from each diet were injected with saline to establish baseline blood parameters and temperature readings. Blood samples, via jugular catheter, and rectal temperatures were obtained immediately before (0 h), then at 2, 3, 4, 5 and 24 h following LPS challenge. On d 17, cattle received a second injection of LPS. Blood samples and rectal temperatures were taken immediately before (0 h), then at 1, 2, 3, 4, 6, and 24 h following LPS challenge. All blood samples were analyzed for concentrations of prostaglandin E₂ (PGE₂), tumor necrosis factor alpha (TNF), fibrinogen (FIB), haptoglobin (HAP), and total white blood cell count (WBC). Body surface temperatures were also measured using an infrared camera. Rectal temperatures at h 3 were greater ($P < 0.03$) for TAL challenged animals than for SOY and tended ($P = 0.08$) to be higher at h 4 for the first LPS challenge. Surface temperatures were not different ($P > 0.7$) for SOY and TAL. TNF after the first challenge was greater ($P < 0.01$) for SOY than TAL at h 2. TNF after the second challenge was greater ($P < 0.03$) for SOY than TAL at both h 1 and h 2. HAP and FIB increased and WBC decreased in response to LPS, but were not different ($P > 0.1$) for SOY and TAL. Concentrations of PGE₂ were variable and not different among treatments ($P > 0.5$). Manipulating dietary lipid sources may alter immune and inflammatory responses in immune challenged cattle.

Key Words: Endotoxin Challenge, Immune Modulation, Lipids

1155 Effects of supplemental high-oleate and high-linoleate safflower seed on fatty acid profiles of adipose tissue, milk, and blood plasma of primiparous beef heifers. J.D. Bottger¹, D.L. Hixon¹, G.E. Moss¹, B.W. Hess¹, R.N. Funston², and D.C. Rule*¹, ¹*University of Wyoming, Laramie*, ²*USDA-ARS, Miles City, MT*.

The objective of this study was to determine effects of supplemental high-linoleate and high-oleate cracked safflower seeds on fatty acid profiles of blood plasma, milk, and adipose tissue of primiparous beef heifers. Thirty-six Angus x Gelbvieh beef heifers were provided ad libitum access to bromegrass hay and given one of three isocaloric and isonitrogenous supplements: corn/soybean meal control (C); cracked high-linoleic safflower seeds (L; 76% 18:2); and cracked high-oleic safflower seeds (O; 72% 18:1). Oil supplements were formulated to provide 5% of total intake as fat. All supplements were individually fed starting 72 h postpartum. Blood was sampled 0, 30, 60, and 90 d postpartum. Milk samples were obtained at the latter three times. Adipose tissue biopsies were taken 0, 45, and 90 d postpartum from the tailhead area. Fatty acid weight percentages were determined using capillary GLC. Heifers supplemented with C had highest ($P < .05$) 14:0, 15:0, 16:0, 16:1, 17:0, and 17:1 in blood plasma, milk, and adipose tissue than O or L heifers. Milk 18:0 was highest in O heifers, plasma of L heifers, and in adipose tissue of C heifers ($P < .05$). Heifers supplemented with L had the greatest ($P < .05$) weight percentage of 18:2 in all tissues; whereas O heifers had the highest ($P < .05$) weight percentage of 18:1 in all tissues. Plasma 18:3 and milk 18:3, 20:4, and 22:5 was greatest ($P < .05$) in the C heifers. Heifers supplemented with O had the highest 22:6 in milk at all time periods ($P < .05$). We conclude that supplemental safflower seeds affect fatty acid profiles of blood plasma, milk, and adipose tissue of primiparous beef heifers. These changes are such that the fatty acids of the particular tissue more closely resemble those of the particular seed being supplemented.

Key Words: Fatty Acids, Safflower Seeds, Beef Heifers

1156 Effects of feeding calcium salts of CLA to finishing steers. K. J. Gassman*, D. C. Beitz, F. C. Parrish, and A. Trenkle, *Iowa State University, Ames*.

Conjugated linoleic acid (CLA) is present in highest concentrations in foods of ruminant origin. Health benefits as well as changed body composition have been ascribed to feeding CLA to laboratory animals and pigs. Objectives of this study were to determine if feeding Ca-salts of fatty acids of CLA-rich oil would alter performance, composition and quality traits of meat from finishing steers. Thirty mixed-breed steers weighing 360 kg were randomly assigned to three groups and fed corn-based finishing diets (88% concentrate) containing 0, 1.0 or 2.5% (calculated) CLA for an average of 130 d. Feed intake (kg DM/d), ADG (kg) and F/G were 11.2, 9.9 & 9.0 ($P < .01$); 1.52, 1.20 & 1.20 ($P < .01$)

and 7.4, 8.6 & 7.6 ($P < .05$) for 0, 1.0 and 2.5% CLA, respectively. Carcass weight tended to be reduced ($P < .06$) and marbling scores were decreased ($P < .04$) by feeding 2.5% CLA. There were no differences in dressing percent, yield grade or backfat. Percentages of lean in the carcasses calculated from physical separation of the rounds were 73.7, 77.7 and 78.8 ($P < .04$) for 0, 1.0 and 2.5% CLA. CLA concentrations, mg/g of fat extracted from rib fat, round fat, rib lean and round lean were 5.5, 5.4, 5.2 & 6.3; 12.8, 10.8, 8.2 & 10.2 and 20.4, 16.5, 12.4 & 12.6 for 0, 1.0 and 2.5% CLA. Increasing CLA in beef had no effects on shelf life (TBAs), tenderness (Warner-Bratzler, sensory) and juiciness, flavor or flavor intensity (sensory) of rib steaks. It is concluded that feeding Casalts of CLA to finishing steers increased CLA concentration in lipids of adipose and lean tissue and increased the percentage of carcass lean, but decreased feed intake and rate of gain.

Key Words: Cattle, CLA, Beef

1157 Effect of high oil corn or added corn oil on ruminal biohydrogenation and conjugated linoleic acid formation. L. R. Kennington^{*1}, S. K. Duckett¹, J. G. Andrae¹, C. W. Hunt¹, F. N. Owens², and G. T. Pritchard¹, ¹University of Idaho, Moscow, ²Optimum Quality Grains, L.L.C., Des Moines, IA.

Three Angus steers (511 kg) cannulated in the rumen and at the proximal duodenum were used in a replicated 3 x 3 Latin Square. Dietary treatments included 1) typical corn (TC, 2.8% fatty acids, 79.2% of diet DM), 2) high oil corn (HOC, 5.5% fatty acid, 79.2% of diet DM), and 3) typical corn + corn oil (OIL, 5.1% fatty acids, 76.9% typical corn plus 2.37 % corn oil). All diets contained 14% grass hay and 6.8% supplement. Typical and high oil corns were isogenic. Duodenal samples were collected for 4 d following 10-d diet adaptation periods. Ruminal biohydrogenation of total unsaturated 18-C fatty acids was greater ($P < .05$) for HOC and OIL than for TC (72.8 and 69.2%, respectively) though responses for individual fatty acids differed with diet. For oleic acid (C18:1), biohydrogenation was greater ($P < .05$) for HOC than OIL and TC diets; for linoleic acid (C18:2), biohydrogenation was greater ($P < .05$) for OIL than HOC and TC diets; and for linolenic acid (C18:3), biohydrogenation was greater ($P < .05$) for OIL and HOC than TC diets. Despite less biohydrogenation, the amounts of unsaturated 18-C fatty acids in the duodenal digesta (dry matter basis) were 23% and 45% higher ($P < .05$) with HOC and OIL diets than the TC diet. The amount (mg/g) of trans-11-vaccenic acid in the duodenal digesta was higher ($P < .05$) for OIL than TC with HOC being intermediate. The amount (mg/g) of conjugated linoleic acid (CLA), c9t11, was similar ($P > .05$) between diets but numerically greatest with HOC. The t10c12 isomer of CLA was detected in the duodenal digesta only from steers fed the OIL diet. Although biohydrogenation was greater for HOC and OIL diets than typical corn diet, the supply of unsaturated fatty acids in the duodenal digesta still was greater for HOC and OIL because greater amounts were provided in the diet. The amount of trans-11-vaccenic and CLA also was greater with HOC and OIL diets than the typical corn diet.

Key Words: High oil corn, Biohydrogenation, CLA

1158 Dietary sunflower oil increases conjugated linoleic acid (CLA) concentration in beef. M. Griinari¹, K. Hissa², and E.-L. Ryhanen^{*3}, ¹University of Helsinki, ²Suomen Rehu Oy, ³MTT, Agric. Research Center.

Milk and ruminant meat are the main sources of CLA in our diets. The effect of feeding on milk fat concentration of CLA has been demonstrated in a number of studies. However, the effect of feeding on concentration of CLA in ruminant meat has been examined only in a few studies. The objective of the present study was to examine the effect of dietary addition of sunflower oil (SFO) on concentration of CLA in beef fat. Four groups (n = 6) of Ayrshire bulls (age 6 months and 301 ± 18 kg live weight) were fed a diet of barley based compound feed and grass silage (40 and 60% of dry matter intake, respectively) for 6 months and supplemented with SFO (% of concentrate) according to the following scheme 1) control (C), 2) 4% SFO for the last 3 months (4%/3 mos.), 3) 4% SFO for 6 months (4%/6 mos.), 4) 8% SFO for the last 3 months (8%/3 mos.). Weight gains over the 6-month period did not differ among the treatments and they averaged 1100 g/d. Carcass weights were also similar across the treatments and averaged 267 kg. Concentration of CLA in tissue samples varied depending on the tissue site and generally increased as the level of SFO addition and the duration of the SFO

feeding increased. These results demonstrate, that dietary addition of sunflower oil is a feasible strategy to increase concentration of CLA in beef. Forage:concentrate ratio is likely to be an important determinant of the dietary oil response.

	Control	4% /3 mos.	4%/6 mos.	8%/3 mos.
Weight gain, g/d	1120 ± 81 ¹	1090 ± 80	1110 ± 95	1090 ± 81
Carcass weight, kg	266 ± 14	268 ± 15	267 ± 21	267 ± 14
Fat content, %				
Steak	1.6 ± 0.2	2.2 ± 0.5	2.4 ± 0.5	2.5 ± 0.8
Flank	21.3 ± 4.1	24.3 ± 6.5	26.7 ± 8.4	22.3 ± 1.8
CLA, % of fatty acids				
Kidney fat	0.29 ± 0.04	0.36 ± 0.06	0.45 ± 0.09	0.45 ± 0.11
Steak	0.40 ± 0.04	0.53 ± 0.09	0.65 ± 0.10	0.74 ± 0.20
Flank	0.53 ± 0.05	0.67 ± 0.11	0.84 ± 0.15	0.85 ± 0.22

¹Values are mean ± standard deviation

Key Words: CLA, Beef, Sunflower oil

1159 The influence of linoleamide on linoleic acid concentrations in ruminal in vitro cultures and in duodenal contents of sheep. T. C. Jenkins^{*}, Clemson University, Clemson, SC.

The objective of this study was to determine if linoleamide resisted biohydrogenation and could increase linoleic acid (L) concentrations in rumen in vitro cultures or in duodenal contents of sheep. Both the in vitro substrate (ground grass hay) and the sheep diets contained either no added lipid (C), added unprotected fat as linoleic acid (UF), or added protected fat as linoleamide (PF). Fats were added at 10% of the in vitro hay substrate or at 5% of the sheep diets (DM basis). The three substrates were incubated with mixed ruminal microbes in triplicate and 5 mL of culture contents were taken at 0, 24, and 48 h for analysis of L by gas chromatography. The concentrations of corrected L at 0, 24, and 48 h were 2.51, 0.38, and 0.11 mg/5 mL for the UF cultures compared to 2.10, 1.35, and 1.08 mg/5 mL for the PF cultures. Three sheep with duodenal cannulae were fed diets C, UF, and PF in a 3 x 3 Latin square with 2 wk periods. Dry matter intakes were not affected ($P > 0.05$, SEM=196) by diet and averaged 1097, 1426, and 1139 g/day for diets C, UF, and PF, respectively. The UF diet increased ($P < 0.05$) daily consumption of L from 11.9 to 45.8 g/day. Intake of L for the PF diet averaged 32.6 g/day and was lower ($P < 0.05$) than the UF diet. Duodenal L concentration averaged 5.0% of total fatty acids when sheep were fed diet C. Both the UF and PF diets increased ($P < 0.05$, SEM = 1.2) L in duodenal samples (14.0 and 12.5% of total fatty acids, respectively). However, each sheep responded differently to the fat supplements. The concentration (% of total fatty acids) of L in duodenal contents for diets C, UF, and PF were 2.2, 11.5, and 16.1 for sheep 82, were 7.6, 21.3, and 14.1 for sheep 86, and were 5.3, 4.7, and 11.9 for sheep 89, respectively. In this study, the amide form of L was more effective than the free acid in enhancing the concentration of L in ruminal cultures but the two forms were equally effective in enhancing L in the duodenal contents of sheep. Differences in duodenal L concentrations between the amide vs free acid forms were affected by differences in L intake (29% lower for PF), variation among animals, and incomplete biohydrogenation of UF (which increased duodenal L concentration 180% over C).

Key Words: Linoleamide, Duodenum, Sheep

1160 Biohydrogenation of unsaturated fatty acids in continuous culture fermenters fed orchardgrass or clover with three levels of ground corn supplementation. J. J. Loo^{*1}, W. H. Hoover², T. K. Miller-Webster², C. E. Polan¹, W. A. Wark¹, and J. H. Herbein¹, ¹Virginia Polytechnic Institute & State University, Blacksburg, ²West Virginia University, Morgantown.

Concentrations of intermediates in the biohydrogenation of unsaturated fatty acids were determined in continuous cultures of mixed rumen microorganisms using two forages with three levels of ground corn as substrates. Orchardgrass and clover were harvested in Virginia during spring and fall, frozen, ground (6 mm), re-frozen, and transported to West Virginia. During 10-d incubations, fermenters were fed (25 g/12 h) only forage (50 g/d), 42 g/d forage + 8 g/d corn, or 34 g/d forage

+ 16 g/d corn. Linoleic (18:2) and linolenic (18:3) were the primary fatty acids in spring orchardgrass (15% 18:2, 47% 18:3), fall orchardgrass (13% 18:2, 47% 18:3), spring clover (16% 18:2, 39% 18:3), and fall clover (18% 18:2, 30% 18:3). Corn grain contained 34% c9-18:1, 52% 18:2, and 1% 18:3. The total effluent for the last 3-d of incubations was composited, and 500 mg of dry sample used for lipid extraction and fatty acid analysis. Overall, effects of season on fatty acid profiles in fermenters were minor compared with those due to forage type. Concentration of c9,t11-18:2 in effluents from clover (1.2 mg/g total fatty acids) was greater compared with those from orchardgrass (0.8 mg/g), and it increased by 75 and 47% with corn supplementation in effluents from clover and orchardgrass. Concentrations of t10-18:1 (11 vs. 7 mg/g), t11-18:1 (184 vs. 133 mg/g), and 18:0 (358 vs. 234 mg/g) in effluents from orchardgrass were greater compared with those from clover. Replacing portions of each forage with corn nearly doubled t10-18:1 concentration. However, addition of corn (0 to 16 g/d) decreased t11-18:1 in effluents from orchardgrass (184 to 151 mg/g), whereas corn increased t11-18:1 in effluents from clover (133 to 151 mg/g). Concentration of t10,c12-18:2 (0.3 mg/g) was similar across treatments and not affected by corn supplementation. Outflow of t11,c15-18:2 was greater for clover (110 mg/g) compared with orchardgrass (33 mg/g), but addition of corn caused a 50% decrease in concentration. Microorganisms hydrogenated unsaturated fatty acids in clover to c9,t11-18:2 and t11,c15-18:2 primarily, whereas in orchardgrass unsaturated fatty acids were hydrogenated to t11-18:1 primarily. Under grazing conditions, *trans* isomers of 18:1 and 18:2 in milk fat may differ due to type of forage and level of grain supplementation.

Key Words: CLA, Trans-10-18:1, Grazing

1161 Dietary milk fat depression and *trans* -18:1 and CLA isomer distribution in milk of lactating cows. L.S. Piperova*¹, B.B. Teter¹, J. Sampugna¹, M.P. Yurawecz², I. Bruckental³, and R.A. Erdman¹, ¹University of Maryland, College Park, ²FDA, Washington D.C., ³Volcani Institute, Bet Dagan, Israel.

Dietary milk fat depression (MFD) is associated with incomplete PUFA biohydrogenation in the rumen and increased *trans* fatty acids (tFA) and conjugated linoleic acid (CLA) content in milk. The objectives of this study were to examine the CLA and tFA isomer profiles in milk fat of lactating cows fed a MFD diet. Twelve multiparous Holstein cows in mid lactation were fed a Control diet (CT), containing 60% forage and 40% concentrate for a 2 week preliminary period. The cows were divided into 2 groups and fed either the CT diet or a high concentrate diet with 25% forage, and 70% concentrate supplemented with 5% soybean oil (HO), in a single reversal design. Milk samples were collected at the end of each treatment period. The analysis of the CLA methyl esters were performed by GC and Ag⁺HPLC. The individual *trans*-18:1 isomers were analyzed, using Ag⁺TLC and GC (100 m, SP 2560 capillary column). The HO diet decreased milk fat content by 43% (P<0.001). The total CLA were increased from 5.6 to 9.5mg/g fat, but the yield of total CLA (g/day) was not different from the CT. The *trans*-18:1 fraction in milk was increased from 1.9% to 15.6% (P<0.001) when the HO diet was fed. These changes were related to specific alterations in tFA and CLA isomer profiles. A ten fold increase in *trans*-10, *cis*-12 (P<0.001) and three fold increase in *trans*-7, *cis*-9 CLA (P<0.001) was observed in cows fed the HO diet. The *trans*-10-18:1 was the predominant *trans* monoene in the milk fat during MFD, representing around 60% of total tFA. The percent of *cis*-9, *trans*-11 CLA (P<0.001) and *trans*-11-18:1 (P<0.001) isomer was decreased during MFD. Except for *trans*-15 and 16 which were not affected by the HO diet, the amount (g/day) of all other *trans*-18:1 isomers was increased. The shift in the tFA and CLA isomer profiles indicated that the effects of the HO diet on milk fat synthesis were mediated via changes in rumen environment. The results are consistent with an effect of the *trans*-10, *cis*-12 CLA isomer on milk fat synthesis, but other changes observed in tFA and CLA isomers may also be important.

Key Words: Trans-18:1 Isomers, CLA, Milk Fat Depression

1162 Comparison of *trans* octadecenoic isomer profiles in duodenal and milk lipids of cows fed different diets. L. Piperova, J. Sampugna, B. Teter*, K. Kalscheur, and R. Erdman, University of Maryland, College Park.

This study was undertaken to examine the *trans* fatty acid (tFA) isomer distribution in duodenal and milk samples previously collected from

lactating cows fed high concentrate (HC) or low concentrate (LC) diets with or without buffer addition. Four multiparous rumen fistulated Holstein cows in mid-lactation were fed different diets in a 2x2 factorial, 4x4 Latin square design with 3 week treatment periods. The diets had two levels of forage 25% (HC) or 60% (LC) with buffer (B) or without buffer (NB) (1.5% NaHCO₃ and 0.5% MgO). Milk fat depression (MFD) was observed only during the HC+NB treatment period and compared to the HC+B diet, the HC+NB diet resulted in increased tFA content in both the duodenal contents (66g/d vs. 120g/d) and the milk fat (33g/d vs. 56 g/d). Fatty acid butyl esters prepared from milk fat and duodenal samples were submitted to argentation TLC to obtain the total tFA fraction, which was separated using GLC (100m SP2560 capillary column) to obtain estimates of the individual *trans*-18:1 isomers. Except for the 6+7+8 and 13+14 positional isomers, all of the others were sufficiently resolved to allow individual quantification. In general the isomer patterns in the milk fat paralleled those observed in the duodenal samples. The distribution of isomers in the milk of cows fed LC+B, LC+NB, and HC+B diets was similar, with the major isomer, *trans*-11, being about 30% of total tFA. In cows fed HC+NB there was an increase in *trans*-9, 10, and 12 in the milk and the percent of the *trans*-10 isomer in the duodenal and milk samples of these cows was similar to that of the *trans*-11 (about 25 to 30%). In contrast, there was approximately three times more *trans*-11-18:1 than *trans*-10-18:1 in cows that were not milk fat depressed. This three fold ratio was also observed in preliminary studies involving cows fed oil supplemented diets which resulted in high levels of tFA in the duodenum and milk, but which did not result in MFD. Regardless of the tFA content, the only diet which reduced milk fat, HC+NB, also lowered rumen pH. These results demonstrate that alterations in rumen environment which change the tFA isomer pattern are characteristic of MFD.

Key Words: Trans-18:1 Isomers, Milk Fat Depression

1163 Effect of type and level of dietary fat on rumen fermentation and performance of dairy cows fed corn silage-based diets. S. G. Onetti*, R. D. Shaver, and R. R. Grummer, University of Wisconsin, Madison.

Response to supplemental fat may vary depending on the level of dietary fat, fatty acid profile of the fat source, feed ingredients of the basal diet, or interactions between fat source and diet. The objective of this study was to investigate the effects of tallow (T) and choice white grease (CWG) fed at two levels on rumen fermentation and performance of dairy cows when corn silage is the sole forage source. Fifteen Holstein cows averaging 117 DIM were used in a replicated 5 x 5 Latin square design with 21-d periods. Treatments were 0% fat (control), 2% T, 4% T, 2% CWG, and 4% CWG (DM basis). The forage:concentrate ratio was 50:50, and diets were formulated to contain 32% NDF and 18% CP (DM basis). Cows were allowed ad libitum consumption of diets that were fed twice daily as TMR. Data are summarized in the table. Cows fed supplemental fat had lower DMI, produced less milk and milk fat, and had a lower acetate:propionate ratio (A/P) than control cows. There was no effect of fat source on DMI, milk production, or rumen measurements. Feeding 4% supplemental fat reduced milk production relative to feeding 2% fat, but there was no significant effect on any of the other parameters measured. There was a significant source of fat x fat level interaction for milk fat % and fat yield (kg fat/d). Including fat in corn silage-based diets had negative effects on production and rumen fermentation regardless of the source or level of supplemental fat.

	Control	2% T	2% CWG	4% T	4% CWG	Significant effects p<.05 ¹
DMI (kg/d)	26.28	24.82	24.39	23.69	23.81	A
Milk (kg/d)	42.28	40.75	41.54	38.07	38.06	A, C
Fat (%)	3.30	2.83	2.93	3.00	2.85	A, D
Fat (kg/d)	1.39	1.14	1.21	1.12	1.08	A, D
pH ²	5.97	6.07	6.06	5.97	6.04	
VFA (mM) ²	131.8	120.9	128.9	123.6	125.1	
A/P ²	2.25	1.78	1.89	1.70	1.77	A

¹A= control vs. fat, B= T vs. CWG, C= 2% vs. 4%, and D= type x level of fat interaction. ²4 h post-feeding

Key Words: Type and Level of Fat, Rumen fermentation and Milk fat, Corn silage

1164 Influence of fat supplementation on rumen fermentation and performance of dairy cows receiving diets with different corn silage:alfalfa silage ratios. S. G. Onetti*¹, R. R. Grummer¹, R. D. Shaver¹, and D. L. Palmquist², ¹University of Wisconsin, Madison, ²The Ohio State University, Wooster.

Supplementing 2 or 4 % tallow or choice white grease (DM basis) to diets containing corn silage as the sole forage source has negative effects on milk production and rumen fermentation. We hypothesized that supplemental tallow will have decreasing negative effects on rumen fermentation, DMI, and milk fat percentage as the dietary ratio of alfalfa silage:corn silage is increased. Eighteen Holstein cows averaging 134 DIM were used in a replicated 6 x 6 Latin square design with 21d periods. Treatments were arranged in a 2 x 3 factorial design with 0% or 2% tallow (DM basis) and 3 forage treatments: 1) 50% of DM as corn silage, 2) 37.5% corn silage and 12.5% alfalfa silage, and 3) 25% corn silage and 25% alfalfa silage. Cows were allowed ad-libitum consumption of a TMR. Diets were formulated to contain 18% CP and 32% NDF. Fat supplemented cows had lower DMI and produced more milk with less milk fat content relative to non-supplemented cows. Increasing the proportion of alfalfa silage increased DMI, milk fat % and yield regardless of the fat content of the diet. Cows that received 2% tallow had a higher rumen pH, but there was no effect on total VFA or acetate:propionate ratio (A/P). Increasing the alfalfa silage:corn silage ratio resulted in an increase in pH and A/P for diets with or without fat. These results suggest there are no beneficial effects of replacing corn silage with alfalfa silage when tallow is supplemented at 2% of diet DM.

Corn Silage	0% tallow			2% tallow			Significant effects p<.05 ¹
	50	37.5	25	50	37.5	25	
DMI (kg/d)	23.16	24.64	24.67	22.35	23.73	23.97	A, B, C
Milk (kg/d)	35.17	36.60	36.17	37.46	36.99	37.73	A
Fat (%)	3.11	3.17	3.32	2.82	2.97	3.06	A, B
Fat (kg/d)	1.06	1.15	1.19	1.05	1.09	1.13	B
pH ²	5.69	5.76	5.91	5.84	5.86	5.95	A, B
VFA (mM) ²	120.3	118.0	118.0	109.7	116.4	119.8	
A/P ²	2.00	2.03	2.21	1.98	1.94	2.24	B, C

¹A= main effect of fat, B= linear effect of forage, C= quadratic effect of forage. ²4 h post-feeding

Key Words: Tallow, Rumen fermentation and Milk fat, Corn silage and Alfalfa silage

1165 Effect of long chain fatty acids on lactation performance and reproductive tissues of Holstein cows. C.R. Staples*¹, M.C. Wiltbank², R.R. Grummer², J. Guenther², R. Sartori², F.J. Diaz², S. Bertics², R. Mattos¹, and W.W. Thatcher¹, ¹University of Florida, Gainesville, ²University of Wisconsin, Madison.

The objective was to examine effects of specific fatty acids on milk production and composition, on a synchronized estrous cycle, and on the uterine secretion of PGF_{2α} of early postpartum dairy cows. Various fat sources were prepared in a Ca salt form and formulated such that a different test fatty acid was delivered to the lower gut. The three fat supplements contained either 57% oleic acid, 45% linoleic acid, or 6.4% eicosapentaenoic (EPA) plus docosahexaenoic (DHA) acids. Fat mixtures were fed at 0 and 2.2% of dietary DM for 42 d. Multiparous cows (n = 29) averaged 64 ± 16 DIM at initiation of dietary treatments. Mean intake of DM (4.15, 4.24, 4.34, and 4.16% of BW, SE=0.02), mean milk production (7-d prior covariate-corrected) (45.0, 46.7, 47.5, and 46.1 kg/d, SE=1.0), and milk fat % (3.66, 3.49, 3.73, and 3.70%, SE=0.16) were similar among cows fed control, high oleic, high linoleic, and high EPA+DHA diets, respectively. Estrous cycles were synchronized using programmed injections of GnRH, PGF_{2α}, and hCG. Blood samples were collected daily for progesterone analysis. Ultrasonography of ovarian structures was performed at strategic times. The number of days between ovulations (23.6, 26.7, 27.6, and 26.3 d, SE=0.8) and for regression of the CL to ovulation (3.7, 5.3, 5.6, and 5.3 d, SE=0.3) were lower for controls. Size of the dominant follicle was greater for cows fed supplemental polyunsaturated fats compared to those fed oleic acid (14.3, 14.4, 17.1, and 17.1 mm, SE=1.2). On d 15 of the synchronized cycle, 20 blood samples were collected from jugular catheters from 1 h before to 4 h after oxytocin injection and analyzed for PGF_{2α} metabolite (PGFM). Differences in PGFM curves were not detected; however, induction of mRNAs for prostaglandin endoperoxide synthase-2 from uterine biopsy was greater for cows fed linoleic acid (124, 103, 230, and 120 copies per

cell, SE=35). Both fat and particular fatty acids can affect ovarian and uterine dynamics.

Key Words: Fat, Ovary, Uterus

1166 Effects of feeding calcium soaps or whole oilseeds on feed intake and lactation performances of dairy ewes. D. R. Osuna, R. Casals*, E. Albanell, and G. Caja, *Universitat Autònoma de Barcelona, E-08193 Bellaterra, Spain.*

Objectives were: 1) to study the lactational effects of feeding supplemental fat coming from calcium soaps of palm oil fatty acids (CaS), whole cottonseed (WCS) or sunflower seeds (SFS), and 2) to compare the effects of fat supplementation in two breeds of dairy ewes (Manchega, MN; and Lacaune, LC), of different level of production. Experimental design was a replicated 4x4 latin square (3 wk periods), using 8 ewes of each breed (60 DIM) individually fed. Diets were offered as TMR, containing (DM basis) 18% corn silage, 23% dehydrated whole-plant corn, 23% dehydrated alfalfa, and 36% concentrate, where fat supplements were included. Treatments were: 1) Control (C); 2) 3.8% CaS (Magnapac[®]); 3) 14.2% WCS; and 4) 5.6% SFS. Diets were isonitrogenous (16% CP) and their ether extract increased from 2.7% (C) to 5.7% (fat supplemented). Feed intake (MN: 2.1, LC: 2.9 kg MS/d) and milk production (MN, 0.8; LC, 1.7 kg/d) were affected by the breed (P < 0.001), but not by fat supplementation. However, milk fat percentage increased (P < 0.05) in MN (C, 7.25; CaS, 8.63; WCS, 7.96; SFS, 7.73%) and LC ewes (C, 6.18; CaS, 7.46; WCS, 7.31; SFS, 6.98%) due to fat supplements. Milk protein (MN, 6.4; LC, 5.7%) and casein content (MN, 78; LC, 76% of CP) of milk were not significantly affected by treatments, but tended to be higher with WCS and lower with CaS. No interactions were found between breed and fat supplementation, despite the observed differences between MN and LC ewes in milk yield, and fat and protein percentages. Results suggest changes in the milk fatty acid profile and indicate a reduction (P < 0.05) of spontaneous lipolysis (0 to 24 h) of milk from ewes receiving fat (C, 31.2; CaS, 15.7; WCS, 18.1; SFS, 14.1 mg C₁₆/100 g of fat). In conclusion, fat supplements, specially CaS and WCS, may help farmers to produce milk with high fat content, in accordance with spanish Manchego Cheese industry requirements. Acknowledgments: CICYT-Spain (Project AGF99-0773) and Norel S.A.

Key Words: Dairy Sheep, Calcium Soaps, Cottonseed and Sunflower Seeds

1167 Milk composition in Holstein cows fed canola oil in various forms. E. Desilets*, D. Pellerin, and P.Y. Chouinard, *Laval University, QC, Canada.*

Use of calcium salts of fatty acids from canola oil in dairy cows diets was previously reported to reduce milk fat content, and to increase the proportion of conjugated linoleic acid (CLA) in milk fat (Chouinard et al. 1998. J. Dairy Sci. 81:471). The objective of this study was to determine if free canola oil or whole canola seed could lead to similar effects on milk composition. Eight Holstein cows in midlactation were used in a replicated 4 x 4 Latin square design with three weeks periods. Treatments were: CO) control diet, CS) control diet + 4% calcium salts of fatty acids from canola oil, FO) control diet + 4% free canola oil, and WS) control diet + 10% whole ground canola seed (DM basis). Diets were fed as TMR once a day and were formulated based on NRC (1989) recommendations. The addition of canola oil (FO, CS, or GS) increased the concentration of dietary ether extract from 4.8 to 8.3% on average. Milk yield and DMI were not influenced by treatments. Milk fat percentage was reduced when CS were fed compared to CO (-11%; P = 0.06). Feeding FO or WS had no effect on milk fat content. Dietary treatments did not affect milk protein and lactose (P > 0.1). Supplementation of canola oil (FO, WS, and CS) decreased the proportion of saturated fatty acid from C6 to C17, and increased the proportions of C18:0 and cis-C18:1 in milk fat (P < 0.01). Feeding canola oil in various forms also increased milk fat content of trans-C18:1, and the increase was greater for cows fed CS as compared with FO or WS (P < 0.01). Milk CLA contents were lower for cows fed CO (6.5^c mg/g fat), intermediate for cows fed WS (10.1^{bc} mg/g fat) and FO (12.1^b mg/g fat), and higher for cows fed CS (17.1^a mg/g fat). Since CLA have been demonstrated to have a range of positive health effects, feeding canola oil as calcium salts seems to be the best way to improve the nutritional

value of milk fat. Project supported by Dairy Farmers of Canada and NSERC.

Key Words: Milk fatty acids, Canola oil, CLA

1168 Production performance of Holstein cows fed canola oil in various forms. E. Desilets*, D. Pellerin, and P.Y. Chouinard, *Laval University, QC, Canada.*

Dietary fat is used to increase energy value of dairy diets, but its use may cause digestive problems. The objective of this study was to determine the effect of feeding canola oil in various forms on nutrient digestibility and production performance in lactating dairy cows. Eight Holstein cows in midlactation were used in a replicated 4 x 4 Latin square design with three weeks periods. Treatments were: CO) control diet, CS) control diet + 4% calcium salts of fatty acids from canola oil, FO) control diet + 4% free canola oil, and WS) control diet + 10% whole ground canola seed (DM basis). Diets were fed as TMR once a day and were formulated based on NRC (1989) recommendations. Total tract apparent digestibilities of DM and dietary nutrients were determined using chromic oxide as a marker. The addition of canola oil (FO, CS, or WS) increased the concentration of dietary ether extract from 4.8 to 8.3% on average. Dietary treatments did not affect apparent digestibilities of DM, OM, CP, ADF, NDF, and cellulose ($P > 0.1$). Apparent digestibility of dietary ether extract was 40.0%^c, 59.3%^{ab}, 72.0%^a, and 53.6%^{bc} for CO, CS, FO, and WS, respectively. Dry matter intake, milk yield and feed efficiency (kg FCM/kg DMI) were not affected by treatments ($P > 0.1$). The BW was higher for cows fed FO (691^a kg) and CS (697^a kg) as compared with those fed WS (684^b kg) or CO (682^b kg) ($P = 0.06$). This increase in BW could be related to the higher digestive utilisation of ether extract for cows supplemented with FO or CS. Feeding canola oil as SC or FO increased the availability of fat for absorption as compared with WS without affecting total tract apparent dry matter digestibility. Project supported by Dairy Farmers of Canada and NSERC.

Key Words: Dairy cows, Canola oil, Ca salts of fatty acids

1169 The effect of abomasal infusion of conjugated linoleic acid on milk fat of lactating dairy cows. J.C. Thorson*, R.A. Erdman, L.S. Piperova, B.B. Teter, J. Sampugna, and T.L. Auchtung, *University of Maryland, College Park.*

Previous experiments with abomasal infusion of conjugated linoleic acid mixtures (CLA) have shown a decrease in milk fat in lactating dairy cows. Two experiments were conducted using abomasal infusion of a CLA mixture in lactating cows to determine: 1) the length of time after cessation of CLA infusion for the milk fat to return to control levels, and 2) to examine the dose response of milk fat to increasing rates of abomasal CLA infusion. In Experiment 1, five rumen fistulated multiparous Holstein cows in mid lactation were abomasally infused with 90g per day of a commercial CLA mixture (CLA 60, Jarrow's Formulas Inc, Los Angeles, CA) for five days followed by a 12 day post-infusion period. Six non-fistulated cows were maintained as controls during the experiment. All cows were fed a diet containing 55% forage:45% concentrate as a total mixed ration. Milk samples were collected twice daily and analyzed for milk composition. Milk fat was reduced by 45% (2.13 in CLA vs. 3.89 in controls, $P < 0.0001$) in the CLA infused cows at the end of the second day of infusion and remained constant through the end of infusion. Milk fat percent did not return to the control levels until day 6 post infusion. These results suggest a substantial carryover effect of abomasal infusion of CLA on milk fat synthesis. In Experiment 2, four rumen fistulated cows used in Experiment 1 were infused with 0, 10, 30 or 90 g/day of CLA-60 corresponding to 0, 6, 18, and 54 g of CLA for 5 days in a 4x5 Latin rectangle design. A 9 d recovery period was used between each infusion to reduce carryover effects. Milk samples for analysis were collected at the end of each infusion period. Cows were fed the same diet as in Experiment 1, but 100g of corn oil was used as carrier during infusion. Milk fat percent decreased linearly (3.89, 3.33, 2.91, and 2.76%) with increasing amount of CLA infused ($P < 0.03$). Milk production was not changed by CLA infusion. Maximum rates of milk fat depression occurred with as little as 30g of CLA mixture infusion (18g CLA) confirming the potent effect of CLA on fat synthesis.

Key Words: Conjugated Linoleic Acid, Milk Fat Depression

1170 Contribution of dietary roasted soybeans and milk components to the development of spontaneous oxidized milk flavor. J. S. Timmons*, W. P. Weiss, D. L. Palmquist, and W. J. Harper, *OARDC / The Ohio State University, Wooster, OH.*

The effects of feeding roasted whole soybeans (RSB) on the milk fatty acid profile and the development of spontaneous oxidized flavor were determined in a field study performed from December, 1998 through April, 1999 using 20 herds in the vicinity of Wooster, Ohio. Herds were fed 0 to 15.3% of diet DM as RSB. Storing milk at 4°C for 3 days, reduced concentrations of α -tocopherol, β -carotene, and ascorbic acid and increased flavor score at 3 and 8 d. Concentrations of milk fatty acids did not change during 8 d of storage. The development of spontaneous oxidized flavor at day 8 post-sampling was correlated with increased concentrations of polyunsaturated milk fatty acids ($r = 0.51$), RSB ($r = 0.33$), and copper ($r = 0.26$) in the milk. The concentrations of polyunsaturated milk fatty acids ($r = 0.82$) in particular 18:2 ($r = 0.86$) and 18:3 ($r = 0.68$) were correlated with the amount of dietary RSB. Multiple linear regression models were developed to determine the relationship of measured variables to the development of off-flavor milk at 8 d post-sampling. Xanthine oxidase activity, copper and polyunsaturated milk fatty acids in milk and dietary RSB were related to increased flavor score ($P < 0.10$). This study suggests that RSB increased the polyunsaturated fatty acid content in milk fat, thereby increasing the susceptibility of milk to spontaneous oxidation.

Key Words: Roasted Soybeans, Spontaneous Oxidized Flavor, Milk Fatty Acids

1171 Ruminant lipolysis and biohydrogenation of long-chain fatty acids. P. J. Moate*, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The accuracy with which nutrition models (such as CPM-Dairy) can predict total fat concentration and the concentrations of the major fatty acids in milk will depend on an accurate estimation of the rates of lipolysis (Klip) and biohydrogenation (Kb) of long-chain fatty acids (LCFA) in the rumen. Objectives of this research were to estimate Klip of the major fat sources and the Kb of C18 fatty acids. To estimate these, we developed a model of the lipolysis / biohydrogenation processes. The main model assumptions are: dietary lipid first either passes out of the rumen or undergoes lipolysis in the rumen to produce free LCFA. In the rumen, LCFA containing 18 carbon atoms are biohydrogenated in a stepwise process (C18:3 \rightarrow C18:2 \rightarrow C18:1trans \rightarrow C18:0; C18:1cis \rightarrow C18:0). At each step, the specific fatty acid can either pass out of the rumen or be biohydrogenated. Data used were from 30 dietary ingredients in 16 diets from four published experiments that reported daily intakes and duodenal flows of LCFA in dairy cows. We used an XL spreadsheet to iteratively alter Klip and the Kb to obtain a "best fit" of the model predictions to observed duodenal flows of LCFA. The estimated Klip (%/h) of lipids from forages, concentrates, tallow, and megalac are 115, 60, 50 and 45, respectively. These Klip are reduced by 5% for each % of dietary LCFA. The estimated Kb (%/h) of C18:3, C18:2, C18:1 trans and C18:1cis are 58, 50, 22 and 13, respectively. The Kb of a specific fatty acid is independent of the fat source from which it was derived, and Kb (18:2) is reduced by 5% for each % of dietary C18:2. Sensitivity analysis shows a 10% change in the magnitude of Klip causes less than 3% change in the extent of lipolysis while a 10% change in a particular Kb generally results in < 5% change in the duodenal flow of the relevant fatty acids. These in vivo Klip are consistent with published rates determined in vitro, while the in vivo Kb have similar ranking but are substantially greater than Kb determined in vitro.

Key Words: Rumen, Lipolysis, Biohydrogenation

1172 Ruminant production of long-chain fatty acids. P. J. Moate, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The aim of this research was to develop equations to be used in nutrition models to predict the ruminal production of long-chain fatty acids (LCFA) in dairy cows. Data used were from 31 diets in nine published experiments that reported intakes and duodenal flows of LCFA (g/cow/day). Regression analyses indicated that daily duodenal flows of total LCFA (DTLFA), total C16 fatty acids (DTC16) and total C18 fatty acids (DTC18) were closely related ($R^2 \geq 0.91$) to intakes of total

fatty acid (TIFA), total C16 fatty acids (TIC16) and total C18 fatty acids (TIC18) respectively:

$$\text{DTLFA} = 42.7 (\pm 55.1) + 1.01(\pm 0.06) * \text{TILFA}$$

$$\text{DTC16} = 16.4 (\pm 10.6) + 0.93(\pm 0.05) * \text{TIC16}$$

$$\text{DTC18} = 40.8 (\pm 31.6) + 1.07(\pm 0.05) * \text{TIC18}$$

The intercepts of these equations suggest there is production of LCFA in the rumen and the standard errors indicate production is variable. Further analysis showed that the discrepancies (DisC16, DisC18) between the respective duodenal flows and intakes of total C16 and C18 fatty acids could be described by multiple linear regression equations involving fat-free dry matter intake (FFDMI), bodyweight (BW), TIC16 and TIC18. We conclude ruminally produced LCFA are mainly C18, that the coefficients associated with FFDMI and BW indicate de novo fatty acid synthesis and endogenous fatty acid secretion respectively, and that fatty acid intake has a negative effect on de novo fatty acid synthesis.

Model term	Regression Coefficients (\pm S.E.)	
	DisC16 (g/day)	DisC18 (g/day)
Constant	-217 \pm 24	-295 \pm 92
FFDMI (kg/day)	5.7 \pm 0.7	13.3 \pm 2.8
BW (kg)	0.28 \pm 0.04	0.45 \pm 0.13
TIC16 (g/day)	-0.33 \pm 0.08	-
(TIC16) ²	0.00043 \pm 0.00014	-
TIC18 (g/day)	-	-0.50 \pm 0.18
(TIC18) ²	-	0.00034 \pm 0.00014

Key Words: Cattle, Long-chain fatty acids, Ruminal synthesis

1173 Digestion of long-chain fatty acids in dairy cows. P. J. Moate*, R. C. Boston, and W. Chalupa, *University of Pennsylvania, Kennett Square.*

The accuracy with which nutrition models (such as CPM-Dairy) can predict milk yield and in the future, the concentrations of the major fatty acids in milk, will depend in part on the accuracy with which these programs can predict the true intestinal digestion (absorption) of long chain fatty acids. The objective of this research was to determine the digestion coefficients of the major long chain fatty acids in dairy cows. Data used were from 33 diets in nine published experiments that reported flows of fatty acids (g/day) to the duodenum and to feces. Linear regression analysis was used to relate duodenal flows of specific fatty acids to the quantity of fatty acid apparently absorbed. Y intercepts were generally negative and not significantly different from zero. We interpret this to mean that post duodenal endogenous secretions of fatty acids were negligible. The slopes (true digestibility coefficients \pm SE) for the major fatty acids were: myristic, C14:0 (0.81 \pm 0.06); palmitic, C16:0 (0.76 \pm 0.01); palmitoleic, C16:1 (0.90 \pm 0.13); Stearic, C18:0 (0.71 \pm 0.03); Oleic, C18:1cis (0.88 \pm 0.02); Elaidic, C18:1trans (0.88 \pm 0.02); linoleic, C18:2 (0.82 \pm 0.02) and linolenic, C18:3 (0.82 \pm 0.01). The digestion coefficient for total fatty acids was 0.75 \pm 0.01. Despite the fact that diets covered a wide range in fatty acid intakes as well as diverse fatty acid sources, simple linear regressions could accurately describe the true absorption of the major fatty acids. However, the following quadratic equation better predicted ($R^2 = 0.97$) the absorbed stearic acid (S) from duodenal stearic acid (D):

$$S = -21\pm 13 + 0.99\pm 0.09 * D - 0.00038\pm 0.00011 * D^2$$

We conclude that if duodenal flow of fatty acids is known or can be predicted, the quantity of fatty acids absorbed can be accurately predicted.

Key Words: Cattle, Long-chain fatty acids, Digestibility

1174 Effects of fat with high melting point on ruminal environment and forage digestion in grazing dairy cows. G.F. Schroeder*¹ and G.A. Gagliostro², ¹CONICET-Fac. Cs. Agrarias UNMdP, ²INTA EEA Balcarce, Argentina.

The objective of this study was to determine if saturated fat (tryglycerides, melting point 58-60°C) could affect ruminal parameters and forage cell wall digestion in grazing dairy cows. Six Holstein cows (three in early and three in mid-lactation) fitted with ruminal cannulae were allotted to a replicated 3x3 Latin square with three treatments: 0 kg (T0), 0.5 kg (T0.5) and 1 kg (T1) of hydrogenated dried oil (30% C16:0 and 60% C18:0). Fat was added to basal concentrate composed by ground corn (5 kgDM/d), fish meal (0.4 kgDM/d) and calcium chloride (20 gDM/d) offered in two equal feeds during milking. Cows were under strip grazing in alfalfa (*Medicago sativa*) and orchardgrass (*Dactylis*

glomerata L.) mixed pastures (24.4% DM, 38.2% NDF, 23.4% CP and 73.2% IVDMD). Dacron bags containing fresh forage (5 g DM/bag) were incubated in the rumen and removed at 0, 4, 8, 12, 16, 20, 24, 26, 32, 40 and 48 h. Ruminal pH, NH₃-N concentration, molar proportions of individual volatile fatty acids (VFA) and total VFA concentrations were not changed by treatments. All parameters of in situ disappearance of forage NDF were not affected by fat supplementation. may be a suitable way to avoid the negative effects on rumen environment and fiber digestion of unprotected fat feeding to ruminants

	T0	T0.5	T1	SEM	P \leq
pH	5.7	5.7	5.7	0.05	0.98
NH ₃ -N (mg/dl)	17.8	18.1	14.5	1.53	0.25
VFA (mmol/L)	88.3	85.8	79.3	5.92	0.56
Acetate:Propionate	3.3	3.2	3.1	0.12	0.51
Soluble NDF (%)	0.3	0.3	1.0	0.37	0.36
Degradable (%)	76.9	73.6	75.5	1.59	0.41
Rate (kd) (%/h)	5.5	6.0	5.9	0.59	0.78
Effective degradability (kp= 7%/h) (1)	32.5	32.6	33.6	1.04	0.72

1- Rate of passage assumed

Key Words: fat supplementation, grazing, ruminal digestion

1175 Effect of nonenzymatically browned sunflower seeds on ruminal fermentation and milk composition in dairy cows. R.J. Grant¹, T.J. Klopfenstein¹, K. Fanning*¹, and C. Wilson¹, ¹University of Nebraska, Lincoln.

Our hypothesis was that an effective nonenzymatic browning of ground sunflower seeds would increase mono- and polyunsaturated milk fatty acids with minimal impact on ruminal fermentation. The ground, nonenzymatically browned sunflower seeds (NEBS) that we developed contained 59.5% ruminally undegradable lipid measured in situ. Eight lactating Holstein cows (150 DIM) were assigned to one of four diets in a 4 x 4 Latin square with 3-wk periods. The control diet contained 50% forage (DM basis) with no added lipid. The remaining diets contained 50% forage and 4% added lipid from sunflower oil (SFO), ground, untreated sunflower seeds (GSF), or NEBS. The SFO diet resulted in the lowest ($P \leq 0.05$) DMI (22.3 kg/d), the GSF diet was intermediate (23.5 kg/d), and the NEBS and control diets were similar (24.6 kg/d). Production of 4% FCM was greatest ($P \leq 0.05$) for the NEBS diet (27.8 kg/d), intermediate for the control and GSF diets (25.9 kg/d), and lowest for the SFO diet (23.7 kg/d). Ruminal pH was unaffected ($P \geq 0.10$) by diet (6.18). Fractional digestion rate of NDF from soybean hulls incubated in the rumen was highest ($P \leq 0.05$) for the control and NEBS diets (0.062 /h), intermediate for the GSF diet (0.049 /h), and lowest for the SFO diet (0.039 /h). Ruminal acetate to propionate ratio was lowest ($P \leq 0.05$) for cows fed the SFO diet (3.09), intermediate for the GSF diet (3.69), and highest for the control and NEBS diet (3.80). Milk fatty acids of chain length C14:0 or less were uniformly reduced with addition of oil from any sunflower product. The amount of C16:0 in milk fat was reduced by 56% with SFO, GSF, or NEBS compared with control diet ($P \leq 0.05$). The NEBS diet resulted in the greatest C18:3, C18:2, and C18:1 *cis* fatty acids in milk fat ($P \leq 0.05$). The SFO and GSF diets resulted in elevated C18:1 *trans* fatty acids ($P \leq 0.05$). These results indicate that the oil in NEBS was protected from ruminal fermentation and successfully elevated the poly- and monounsaturated fatty acid content of milk fat. These desirable changes in milk fat composition were coupled with an increase in milk fat production.

Key Words: sunflower seeds, milk fat, dairy cows

1176 Development and application of a mechanistic model to study substrate degradation, microbial synthesis and gas production. J. Dijkstra*¹, J. France², M.S. Dhanoa³, and S. Lopez⁴, ¹Wageningen University, Netherlands, ²The University of Reading, UK, ³Institute of Grassland and Environmental Research, UK, ⁴University of Leon, Spain.

A mechanistic model was developed to study the relationships between substrate degradation, microbial synthesis, and gas production in the *in vitro* gas production technique. The model was based on standard substrate and microbial growth kinetics and consisted of six state variables that represented undegradable substrate (Q_U), insoluble degradable substrate (Q_D), soluble substrate (Q_S), microbial biomass (Q_M),

volatile fatty acids (Q_{VFA}), and gas (Q_G). Hydrolysis of Q_D was assumed to obey mass-action kinetics. Microbial uptake of Q_S was represented by saturation kinetics. The substrate taken up was utilized for microbial growth and non-growth requirements. A fixed microbial non-growth requirement was assumed. The amount of VFA and gas produced were calculated based on stoichiometric principles. Simulations were terminated when non-growth requirements exceeded substrate uptake, representative of the situation of maximal microbial biomass. Gas production profiles were simulated for five feedstuffs with different degradation characteristics. The feedstuffs evaluated were a good (G1) and a poor quality grass silage (G2), sugarbeet pulp (SB), pressed potato pulp (PP) and soy hulls (SH). All simulated cumulative gas production profiles had realistic sigmoidal shapes. Fast degrading feeds reached the point of maximal microbial biomass more quickly than slow degrading feeds. The incubation time at maximal microbial biomass varied between 15.3 (SB) and 27.8 (SH) h. Besides, fast degrading feeds tended to have a higher efficiency of microbial synthesis compared with slow degrading feeds. Microbial efficiency at the point of maximal biomass varied between 257 (SH) and 317 (SB) g microbial biomass / kg substrate truly degraded. The simulations provided a quantitative understanding of the relationships between substrate degradation, microbial biomass, and gas production.

Key Words: Gas Production, Mathematical models

1177 Challenging a model of dairy cattle metabolism to describe responses to dietary rumen undegradable protein content. M. Woodman* and J. McNamara, Washington State University, Pullman.

The objective was to test behavior and sensitivity of a mechanistic model of digestion and metabolism in dairy cattle for describing responses to changes in dietary rumen undegradable (RUP) content. From published literature, a set of 25 treatment groups were collated. Range of milk productions was 18.8 to 35.7 kg/d; DIM was 21 to 136; DMI was 17.2 to 25.4 kg/d. Diets ranged from 14.3% to 23.8% CP with 25.9% to 59% RUP as a percent of protein. Most control diets were soybean-based and test diets were protected soybean, oil seed or animal-based protein. Initial body weights, DIM, DMI, nutrient intake, milk production and milk composition of controls were inputs into the model. The model used was the MOLLY model from the University of California. MOLLY uses feed nutrients as explicit inputs and biochemical equations to describe responses. Dietary protein is allotted to insoluble or soluble, with insoluble protein being slightly higher than the measure of RUP for a given feed. Simulations of predicted milk production (PMP) and predicted protein production (PP) were output by the model. The equation for predicting PMP from observed milk production (OMP) was $PMP = 1.073 \times OMP + 3.002$, $r^2 = .799$, $SE_{xy} = 2.23$. The equation for predicting PP from observed milk protein yield (OP) was $PP = 1.084 \times OP + 0.068$, $r^2 = .736$, $SE_{xy} = .078$. Mean bias was .70 and -.053, line bias was .126 and .00015, and residual bias was 3.30 and .0036 kg/d for milk and milk protein yield. Data and simulations support the concept that substituting soybean protein with increased RUP does not increase milk or milk protein yield at these production levels. The model describes milk and milk protein yield in response to increased RUP within the range of this data. However, it is not adequate to describe the metabolic and production effects of changing RUP such as change in body composition. Further data on effects of changing other dietary ingredients and absorbed amino acid pattern are needed to improve our ability to predict changes to these components.

Key Words: Protein, Model, Lactation

1178 Comparison of predicted changes in duodenal flow of crude protein and amino acids caused by changing the diet fed to lactating dairy cows. H. G. Bateman, II^{1*}, J. H. Clark¹, C. J. Peel², R. A. Patton³, and C. G. Schwab⁴, ¹University of Illinois, Urbana, ²Degussa-Hüls, Inc., Ridgefield Park, NJ, ³Nittany Dairy Nutrition, Mifflinburg, PA, ⁴University of New Hampshire, Durham.

The objective of this research was to investigate the inferences obtained from simulated flows of CP and AA to the duodenum of lactating cows and to compare those inferences with those obtained from measured data. Duodenal flows of CP and AA from 6 research trials published between 1989 and 1995 were simulated using the 1989 NRC equations,

the Mepron Dairy Ration Evaluator (MEPRON), the Cornell Net Carbohydrate and Protein System (CNCPS), the University of Pennsylvania release of the CNCPS (PENN), and the CPM dairy program. Both predicted and measured protein fractions were analyzed by ANOVA and compared to determine if statistical inferences obtained from predictions by the models were similar to those from the measured data. The ANOVA of measured data did not always agree with those for predicted data. All models responded to changes in diet composition and often predicted that dietary changes would result in statistically different amounts of protein and amino acids passing to the duodenum that were not observed in the experimentally measured data. The NRC model predicted the correct direction of change in flow of CP for 40% of treatment comparisons. All other models predicted the correct direction of change in total protein flows for 57 to 60% of the treatment comparisons. However, the PENN, CNCPS, and CPM models only predicted the correct direction of change for AA flows in 45% of the treatment comparisons while the MEPRON model predicted the correct direction of change in AA flows for 60% of treatment comparisons. Discrepancies in ANOVA and interpretations between predicted and measured data may be because of the inherent nature of modeling, associative effects of feeds not accounted for by models, inaccurate equations in the models, inaccurate description of feeds, or experimental error in measured data.

Key Words: Modelling, Protein, Amino Acids

1179 Estimating ruminal crude protein degradation with *in situ* and chemical fractionation procedures. S. Shan-nak, K.-H. Suedekum*, and A. Susenbeth, University of Kiel, Germany.

A new system for the estimation of the protein value of feedstuffs for dairy cattle was recently introduced in Germany. Key variable in the system is the amount of total crude protein (CP) reaching the duodenum ("nutzbares Rohprotein", nXP), which is the sum of microbially synthesized CP and ruminally undegraded CP (UDP) and is estimated from *in vivo* trials on duodenally cannulated dairy cows. The objective of this study was to utilize the fractionation of feed CP of the Cornell net carbohydrate and protein system (CNCPS) as a basis for estimating UDP values of feedstuffs obtained from *in situ* trials. Unlike the CNCPS, our approach aimed at determining one single UDP value for each feedstuff from multiple linear regression equations instead of estimating four different UDP values. Thirty-two feedstuffs were inserted in polyester bags and incubated inside the rumen of three steers. Values for *in situ* UDP at assumed ruminal passage rates of 2, 5, and 8%/h, respectively, ranged from 6 to 57, 12 to 78, and 16 to 84% of CP. When fish meal data (n = 2) were excluded from the data set, multiple regression equations that were based on concentrations of CP and cell wall, and on the A, B, and C fractions of the CNCPS fractionation schedule, explained 85, 93, and 95%, respectively, of the variation in UDP values at assumed ruminal passage rates of 2, 5, and 8%/h. At 8%/h of passage, the difference between UDP values derived from *in situ* and chemical fractionation procedures was greater than five units for only four out of 30 feedstuffs. We conclude that *in situ* UDP values, which serve as one key variable in many protein evaluation systems for dairy cattle, may be reliably and accurately predicted from chemical fractionation of feed CP according to the CNCPS.

Key Words: Rumen, Protein, Cattle

1180 Assessment of the value of cannulated pigs for measuring intestinal protein digestibility of ruminal undegraded protein of canola meal. A. F. Mustafa, J. J. McKinnon*, P. A. Thacker, and S. Y. Qiao, University of Saskatchewan, Saskatoon, Canada.

The objective of the study was to determine whether cannulated pigs could serve as a model to measure intestinal digestibility of ruminal undegraded protein (RUP). Intestinal digestibility of RUP from canola meal (CM) heated at 125 or 145 °C for 0, 10, 20, and 30 min was measured in two experiments using either duodenally cannulated steers or pigs. Two Hereford steers fitted with ruminal and duodenal cannulas were used in the first experiment. Nylon bags containing 1 g of the CM samples were incubated in the rumen for 12 h followed by a 3-h incubation in a pepsin-HCl solution. The bags were then inserted into the duodenum of the steers and recovered in the feces. Rumen undegraded residues were obtained in the second experiment by incubating nylon bags containing the CM samples in the rumen of two fistulated Holstein cows for 12 h. Following incubation, washed rumen undegraded

residues from each treatment were pooled and ground. Nylon bags containing 1 g of rumen undegraded residues with or without pepsin-HCl pre-incubation were inserted in the duodenum of three duodenally cannulated pigs and recovered in the feces. The results showed that intestinal digestibility of RUP for CM heated at 125 °C was similar to unheated CM using both animal models. With both models, heating CM at 145 °C significantly reduced the intestinal digestibility of RUP. The regression equations relating pig and steer estimates showed that cannulated pigs accounted for 96% of the variation in intestinal digestibility of RUP with a standard error of prediction of .073%. When forced through the origin, the bias was 6% overprediction of intestinal digestibility. It was concluded that duodenally cannulated pigs could be used to estimate intestinal digestibility of RUP of heat-treated CM for ruminants. Further studies are required to validate the model for other feedstuffs.

Key Words: Ruminal undegraded protein, Cannulated pig, Intestinal digestibility

1181 Comparison of phospholipid phosphorus and purines as markers of microbial crude protein in duodenal digesta of cattle. R.A. Mass^{*1}, R.A. Drijber¹, K.W. Creighton¹, W.W. Stroup¹, and T.J. Klopfenstein¹, ¹University of Nebraska, Lincoln.

Quantification of microbial CP (MCP) flow from the rumen requires a reliable, accurate MCP marker. Of all the criteria required of a marker, assay ease and precision often limit marker analysis. Although purines (PUR) are commonly assumed to be an accurate microbial marker, that method is deficient in these analytical criteria. Phospholipid phosphorus (PP) has been shown to be highly correlated ($r = .98$) to microbial cell mass and MCP in mixed cultures where radiolabelled phosphorus incorporation was measured. The objective of this experiment was to compare PUR and PP as markers of MCP. Duodenal digesta samples ($n = 12$) were collected as part of another experiment in which cattle were fed different amounts of alfalfa hay. Samples were analyzed in duplicate for both PUR (2 N perchloric acid hydrolysis, silver nitrate in the wash solution) and PP. Estimates of MCP concentration were made by applying marker:MCP ratios obtained from in situ analysis. Alfalfa hay NDF was incubated in situ for 12 h and then analyzed for both markers and CP. There was a positive linear relationship between the MCP estimates from the two methods (MCP from PUR = .63(MCP from PP) + 1.37; $r^2 = .68$). Although it is unclear why the slope of the regression differs from one, we hypothesize that this is the result of marker:MCP ratios which interact between methods and stage of microbial growth. A statistical test of assay precision was conducted by comparing assay mean square errors using an F test. Analytical error for PP tended to be lower ($P = .09$) than PUR, suggesting a difference in precision of these methods. Although the ease of an assay is more difficult to assess, it could be described by the hours of labor required to complete it. For this set of samples, it took 8 h to assay for PUR and 5 h to assay for PP. Similar equipment is required for each assay. Consistency of marker:MCP ratios across rumen microbial growth stages must be clarified before a definite conclusion can be made about the accuracy of PP as MCP marker.

Key Words: Ruminants, Microbial Protein, Markers

1182 Analytical evaluation of a low infusion dose of [¹⁵N¹⁵N]urea to determine urea production, gut entry rate and recycling in dairy cows. H. Lapierre^{*1}, E. Milne², and G.E. Lobley², ¹Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada, ²Rowett Research Institute, Aberdeen, Scotland, UK.

Infusion or injection of [¹⁵N¹⁵N]urea and collection of urine and feces, allows quantification of total urea production (UP) plus partition of the urea-N that enters the digestive tract between catabolism (recycling to the ornithine cycle (ROC) and feces) and anabolism. To assess the potential of the method for dairy cows, the analytical precision was evaluated under conditions that simulate 0.25 of the [¹⁵N¹⁵N]urea dose currently used for sheep. Three criteria needed to be met: precise measurement of 1) lower isotopic enrichment (IE) of [¹⁵N¹⁵N]urea (UP measurement); 2) lower IE of [¹⁴N¹⁵N]urea; 3) the ratio of [¹⁴N¹⁵N] to [¹⁵N¹⁵N]urea (ROC quantification). The precision of the [¹⁵N¹⁵N] measurements was determined on standard solutions (STD), and of [¹⁴N¹⁵N]urea, on urine samples from a previous study involving 4 sheep infused with [¹⁵N¹⁵N]urea. The IE of urea was measured by isotope ratio of N₂ produced by monomolecular reaction of LiOBr on urea: mass 29 refers to N₂ from [¹⁴N¹⁵N]urea and mass 30 to [¹⁵N¹⁵N] urea. The

variances of mass 30 measurements for the STD were small, CV averaged 0.1, 1.5 and 1.8 % for STD of 0.1215, 0.0628 and 0.0324 ape, respectively. The proportion of mass 29 due to the non-monomolecular reaction was not affected by IE ($P > 0.10$; 4.7, 4.6 and 4.3 % of total IE for the 3 STD). Furthermore, the CV for mass 29 of undiluted (0.0299 ape) and diluted (0.0089 ape) urine were 1.1 and 1.0 % respectively. Consequently, the ratio of mass 29:mass 30 IE was not altered ($P > 0.10$; 38.9 and 38.7 %) at lower IE. In the dairy cow, an infusion of 0.15 mmol/h of [¹⁵N¹⁵N]urea would yield an IE of approximately 0.03 ape for mass 30 and thus the total amount of [¹⁵N¹⁵N]urea required for a single dose or a 60-h infusion would be 0.6 g. Urea kinetics can, therefore, be quantified in high yielding dairy cows at doses of [¹⁵N¹⁵N]urea that are economically acceptable.

Key Words: Cow, Urea, Kinetics

1183 Urea flux in beef steers: effects of forage species and fertilization. S. L. Archibeque^{*}, J. C. Burns, and G. B. Huntington, North Carolina State University, Raleigh.

The effects of forage species and fertilization level on urea kinetics and whole body nitrogen (N) metabolism were evaluated in 8 Angus growing steers (initial weight 217 \bar{n} 15 kg, final weight 252 \bar{n} 9 kg). In a replicated 4x4 latin square design, steers were fed four hays, dried with forced air, from two warm season grasses, gamagrass (*Tripsacum dactyloides*, G) and switchgrass (*Panicum virgatum*, S), which were fertilized with either 56.2 (L) or 168.5 (H) kg of N per hectare. Diets were fed to provide adequate energy for 0.5 kg ADG. Following 21d of adjustment, N balance was measured from days 22 - 27 of each period. Bis-¹⁵N urea was infused (0.137 mmol/hr) via a jugular catheter for 56 h and urine was collected from 48-56 h to measure urea kinetics. Jugular blood was collected during the balance trial prior to and at scheduled intervals during infusion, and analyzed for blood urea N (BUN). G differed from S ($P < 0.05$) in daily DMI (4273 vs 4185 g), N intake (72 vs 67 g), DM digestibility (60.95 vs 63.59%), fecal N (30.59 vs 28.33 g/d), urine N (20.19 vs 19.58 g/d), urine urea N (10.54 vs 8.03 g/d), and percent of urinary N present as urea N (53.51 vs 39.99%). By design, daily N intake was lower ($P < 0.05$) for L (63 g) than for H (76 g). L also differed from H in DM digestibility (61.27 vs 63.27%), urine N (13.56 vs 25.94 g/d), and N retained as a percent of N digested (57.3 vs 43.5%). After adjustment by covariance for differences in N intake, fecal N excretion was ($P < 0.09$) greater for G than S. Compared to S, G had greater BUN, N digestibility, and N digested as fertilization level increased (forage x fertilization interactions $P < 0.05$). As fertilization level increased, N retention increased from 19.5 to 23.5 g/d in G and decreased from 20.5 to 18.1 g/d in S (interaction $P < 0.07$). Urea kinetics for one replication of the Latin square (4 steers), indicate that gut entry rate of urea N was greater ($P < 0.10$) for H (31.7 g/d) than for L (25.5 g/d), yet there was no difference ($P = 0.13$) in the amount of N that was recycled to the ornithine cycle (9.8 g/d). In summary, fertilization affected N metabolism of steers more when fed G than when fed S and the bis-¹⁵N urea method of monitoring urea flux appears to be a viable alternative to surgical procedures that have typically been used in the past.

Key Words: Beef Steers, Nitrogen, Forage

1184 A pilot project to introduce the routine use of milk urea N analysis for diet evaluation. J.S. Jonker^{*1}, R.A. Kohn¹, J. High², and A. Grove³, ¹University of Maryland, College Park, ²Lancaster Dairy Herd Improvement Association, Manheim, PA, ³Maryland and Virginia Milk Producers Cooperative, West Reston, VA.

Milk urea N can be used by dairy farmers to monitor the nutritional status of their cows and to examine N nutrient loading to water resources from dairy farms. The objectives of this study were to introduce the routine use of milk urea N to monitor dairy cattle diets and determine the potential economic and environmental impact of overfeeding protein to dairy cows in the Chesapeake Bay drainage basin. A confidential mail survey was conducted with members of the Maryland and Virginia Milk Producers Cooperative ($n = 1156$). A total of 454 dairy surveys (return rate = 39.3%) were returned. All dairy herds from the milk cooperative were tested for milk urea N for six months ending May 1999. Farmers who returned the survey were provided with lab results and recommendations for adjusting diets each month. Milk production was observed

to have the greatest effect on milk urea N presumably because of increased protein requirements for the greater production. Dairy farmers who received our correspondence saw a relative decrease in their milk urea N concentration by 0.52 mg/dl from the beginning to the end of the testing period compared to non-participating farmers. When comparing observed to target milk urea N concentrations, a wide variation in protein feeding management was observed. However, as milk production increased, milk urea N decreased compared to target levels. Over 40% of the dairy farms had milk urea levels above their target concentrations for herds fed according to NRC recommendations. This excess feeding of protein was estimated to reduce net farm income by \$1500/yr per dairy farm due to increased feed costs and reduced milk production. Furthermore, 1.4 million kg/yr of N loading could be reduced if dairy cows were fed according to recommendations. Routine use of milk urea N reduced excess CP being fed to cows, and thereby reduced N excretion and nonpoint N loading to the Chesapeake Bay.

Key Words: Milk Urea N, Chesapeake Bay, Dairy Farm

1185 Post-ruminal delivery of biologically active proteins using *Pichia pastoris*: definition of growth conditions. C. Strauss^{*1}, T. A. McAllister¹, and L. B. Selinger², ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²University of Lethbridge, Lethbridge, AB.

The *Pichia pastoris* expression system could be useful for post-ruminal delivery of protein, but only if the cells remain intact throughout their residence in the rumen, i.e., for at least 12 h, if they associate with the fluid phase of ruminal contents, 36 h if with the particulate phase. Plate counts measure viability, but do not detect non-viable cells that remain cellularly intact. Accurate assessment of integrity following ruminal incubations is pivotal to developing cultivation techniques for large-scale production of transgenic *P. pastoris* as a feed additive for ruminants. The gene encoding Green Fluorescent Protein (GFP) was inserted into *P. pastoris* GS115, which then allowed detection of cellular integrity independent of viability. The recombinant strain was used to identify the fractions of ruminal fluid that effect degradation of *P. pastoris* cells, and to define yeast culture conditions to improve survival of intact *P. pastoris* for passage from the rumen. With the yeast culture conditions used initially, only 35% of *P. pastoris* cells inoculated remained intact after 9 h of incubation in the bacterial (i.e., protozoa-free) fraction of ruminal fluid (RF), compared with 100% maintenance of integrity after 48 h in clarified (cell-free) RF and distilled water ($n = 5$). In contrast, when complex carbohydrates were omitted from the yeast culture medium, cellular integrity was maintained by 100% of *P. pastoris* cells after 36 h of incubation in bacterial fraction ($n = 7$), but by only 28% of cells incubated in whole RF ($n = 3$). Work is ongoing to further define yeast culture conditions to enhance survival of intact *P. pastoris* cells in the presence of ruminal protozoa. Methanol-induced intracellular expression of bioactive peptides, enzymes and high-value proteins in recombinant *P. pastoris* could be effective for providing ruminal escape protein to ruminants, once yeast culture conditions are optimized.

Key Words: Bypass protein, Enzymes, Green Fluorescent Protein (GFP)

1186 Determining protein quality of a supplemental feed block based on whole cottonseed, broiler litter and molasses for growing cattle. D. Kumar^{*}, M.A. Froetschel, H.E. Amos, C.A. McPeake, and M.Q. Lowder, *The University of Georgia, Athens.*

A feed block supplement that contained 25% whole cottonseed, 45% broiler litter and 30% molasses was developed to provide cost-effective nutrition for growing cattle. Depressed post-absorptive concentrations of lysine in growing calves fed the feed product suggests that its utilization was limited by protein quality. The potential to improve protein quality of this feed product was investigated by substituting graded levels (0, 8, 12 and 24%) of a blend of fish meal and dried distillers grains (58:42) for the whole cottonseed and broiler litter in the feed product. Protein quality was determined by measuring nitrogen retention in four Holstein steers (average initial weight = 201 kg) fed feed blocks and free choice Bermudagrass hay in a 4x4 Latin Square designed experiment. Experimental periods were 14 d in length. Feed block and hay intake were measured daily. On day 8 the steers were fit with indwelling jugular catheters and blood sampled at hourly intervals from 0-6 h after feeding and assayed for insulin, glucose, urea N and amino acids. Steers consumed an average 5.42 kg DM/d of feed block and 1.61 kg DM/d of

hay. Steers fed increasing levels of fish meal and dried distillers grains increased N retention in a linear manner ($P < .01$) from 36.0 to 51.1 g/d. Post-ruminal amino acid flow was measured in four ruminally and abomasally cannulated steers (average weight = 496 kg) fed similar levels of the feed blocks and hay, as a % of body weight, for 14 d periods in a 4 x 4 Latin Square designed experiment. Chromic oxide was used as a digestibility marker. Abomasal flow of lysine increased in a linear fashion ($P < .01$) from 54.7 to 79.6 g/d as steers were fed incremental levels of protein supplement. Protein supplementation of a feed block composed of regionally available byproduct feeds should improve cost effective performance of backgrounded cattle.

Key Words: Supplemental feed block, Protein quality, Nitrogen retention

1187 Influence of broiler litter stacking method and monensin inclusion on performance and *Salmonella* shedding of growing calves. D. J. Capucille, M. H. Poore^{*}, and G. M. Rogers, *North Carolina State University, Raleigh.*

An 84-d growing trial was conducted with 60 calves (initial wt. 284 kg) to determine performance on a control diet containing 33% corn silage (CS), 33% cottonseed hulls (CSH), 22% corn and 11% soybean meal (SBM), as compared to broiler litter diets containing 15% CS, 15% CSH, 35% broiler litter (BL) and 35% corn. Broiler litter was *Salmonellae* positive at cleanout and was stacked to a depth of approximately 2.5 m (DS, peak temperature 55 °C), or to approximately 1 m (SS, peak temperature 40 °C). Half the calves on each treatment had monensin included at 30 g/ton DM to make a 2 x 3 factorial arrangement of treatments. After the growing period, calves underwent a shipping protocol, and were then placed on a finishing diet. There were no interactions of diet and monensin. Both types of BL were *Salmonellae* negative at feeding, and biweekly fecal sampling showed no shedding of *Salmonellae* during the growing trial, after shipping, or during the finishing phase. Calves fed the control diet gained faster ($P < .05$) than either BL ration, while calves fed DS tended ($P < .09$) to gain faster than SS (1.53, 1.29, and 1.19 kg/d for control, DS and SS, respectively). Dry matter intake (DMI) tended to be higher for control than DS ($P < .09$) and both were higher ($P < .05$) than SS (10.1, 9.6 and 8.6 kg/d for control, DS and SS, respectively). Feed efficiency was higher ($P < .02$) for control than BL diets, but did not differ between DS and SS (.152, .134 and .138 for control, DS and SS, respectively). Monensin inclusion did not influence daily gain (1.34 kg/d), but decreased DMI ($P < .01$; 9.8 vs 9.1 kg/d) and improved feed efficiency ($P < .02$; .147 vs .136). Diet during the growing phase influenced starting weight on the finishing phase, but had little influence on finishing performance or carcass characteristics. In this study, improper stacking of *Salmonellae* positive BL did not result in detectable *Salmonellae* shedding, but reduced feed intake and cattle performance.

Key Words: Broiler litter, Monensin, *Salmonella*

1188 Determining the energetic value of whole cottonseed as compared to corn and cottonseed meal in a block supplement for growing cattle based on broiler litter and molasses. M. A. Froetschel^{*}, H. E. Amos, D. Kumar, V. Pattarajinda, and C. A. McPeake, *The University of Georgia, Athens.*

There is a significant opportunity to background more cattle in the Southeast if an economical feed supplement was available. A feed product was developed and tested as a supplement in growing beef cattle. The product consisted of 25% whole cottonseed (WCS), 45% broiler litter and 30% molasses and fed as a pressed block. Initial feeding trials indicate that the feed product was palatable, contained 65% TDN and 18% CP and cost from \$.64 - .97 /kg of gain. This feeding trial was conducted to determine the optimal inclusion rate of whole cottonseed in comparison to a mixture corn and cottonseed meal in the feed product fed as a feed-block. Eight growing Angus steers (average initial body weight 234 kg). Feed blocks of varying composition (6.8 kg block plus chopped hay ad-libitum) were fed to each of the steers in a replicated 4 x 4 Latin square designed experiment. The level of broiler litter was set at 45% and molasses at 30%; whereas, the rest of the feed block mixture (25%) consisted of either whole cottonseed or mixtures of ground corn and cottonseed meal. A 60:40 ratio of corn to cottonseed meal was used to substitute for 0, 5, 10 and 15% of the whole cottonseed in the feed block. Steers were fed diets for 28 d periods. Performance of the cattle was assessed by measuring both body weight change and nitrogen balance. Steers were fit with indwelling jugular catheters and hourly blood samples were collected, on d 28, -1 to 8 h after feeding and analyzed for

glucose, insulin and urea nitrogen and plasma amino acids. DM intake of the feed block and hay averaged 1.9 and 1.1% of body weight, respectively. Average daily gain were quadratically related ($P < .05$) to the level of substitution of corn and cottonseed meal for whole cottonseed and was lowest in cattle fed blocks that had intermediate levels of corn and cottonseed meal substitution. Digestible energy and N retention were not influenced by the composition of the feed block ($P > .05$). Even though, the feed product resulted in cost effective gains of growing cattle the higher energy value of WCS relative to a mixture of corn and cottonseed meal was not realized.

Key Words: Supplemental feed block, Whole cottonseed, Digestible energy

1189 Use of concentrated separator by-product in receiving diets for beef steers. E. R. Loe*, M. L. Bauer, G. P. Lardy, and J. C. Caton, *North Dakota State University, Fargo.*

One hundred thirty-two crossbred steers ($263.6 \pm .8$ kg) were fed for 27 d to evaluate effects of concentrated separator by-product (CSB; desugared molasses) on DMI, gain, and health of receiving steers. Steers were shipped 300 km and allowed free access to water and long-stem hay upon arrival. Steers were processed, blocked by previous management, and allotted randomly to dietary treatment. Previous management blocks included 1) weaning day of shipping and 2) weaning at least 3 weeks prior to shipping. Dietary treatments were concentrated separator by-product (CSB) and control (CON). The CSB diet contained 40% dry-rolled corn, 5% CSB, 50% grass-alfalfa hay, and 5% supplement on a DM basis. The CON diet contained 43% dry-rolled corn, 50% grass-alfalfa hay, and 7% supplement on a DM basis. Water was added (equal to the as fed weight of CSB) to CON diet to minimize differences in ration acceptability between treatments. Both treatments were formulated to contain .5 mg/kg decoquinat, 13.5% CP, .85% Ca, .45% P, and a minimum of 1.3% K. Steers were weighed weekly. Initial and final weights were an average of two-d weights. Performance data were analyzed using the GLM procedure of SAS and health data were analyzed with Chi-square. Steers fed CSB had greater DMI (8.3 vs 7.6 kg/d; $P = .06$) and DMI as a percentage of BW (2.70 vs 2.51% BW; $P = .06$). Calves weaned prior to day of shipping were treated fewer times ($P = .002$) for signs of bovine respiratory viral complex than calves weaned day of shipping. Other measurements ($P > .10$) were not affected by treatment. Addition of CSB to receiving diets increases dry matter intake and may be a useful feed ingredient in diets where intake is expected to be low.

Item	Treat ment, %DM		SEM	P
	CSB	CON		
Final weight, kg	307.1	302.8	2.5	.23
DMI, kg/d	8.31	7.64	.23	.06
DMI, %BW	2.70	2.51	.07	.06
ADG, kg/d	1.37	1.23	.08	.20
Gain:Feed	.167	.160	.009	.59

Key Words: Concentrated Separator By-Product, Receiving, Steers

1190 Optimizing the digestion of soybean hulls by limit-fed cattle. A. M. Trater*, E. C. Titgemeyer, C. A. Loest, and B. D. Lambert, *Kansas State University, Manhattan.*

Twenty Holstein steers (319 kg) were used in a randomized complete block design to evaluate the optimal level of alfalfa inclusion in limit-fed, soybean hull-based diets. Treatments were a soybean hull mix (95.7% soybean hulls, 3% molasses, 0.5% urea, 0.8% mineral mix; DM basis) fed with 0, 10, 20, and 30% (DM basis) coarsely chopped alfalfa hay (SH100, SH90, SH80, SH70, respectively), or only alfalfa (ALF). Steers were allotted to four blocks based on body weight. Diets were fed once daily at 1.75% (DM basis) of body weight for 16 d (10-d adaptation, 6-d collection). In some cases orts were present, but intakes of DM and OM were not affected by treatment. However, digestions of DM (DMD) and OM (OMD) for ALF (56.2 and 58.1%, respectively) were lower ($P < 0.01$) than for diets containing soybean hulls (DMD = 67.5, 70.9, 67.2, and 70.9%, SEM = 2.0, and OMD = 68.7, 72.3, 68.6, and 72.3%, SEM = 1.9, for SH100, SH90, SH80, SH70, respectively). There were no differences in DMD or OMD among diets containing soybean hulls, although there were positive associative effects between soybean hulls and alfalfa (significant only for SH70). Liquid and solid passage rates were estimated by labeling a portion of the ration with Cr-EDTA and Yb chloride and subsequently collecting fecal samples 24, 48, 72, and 96 h after dosing (liquid passage) or 48, 72, 96, and 120 h after dosing (solid passage). Liquid dilution rates (4.6, 6.2, 5.6, 7.4, and 7.7%/h,

SEM = 0.5, for SH100, SH90, SH80, SH70, and ALF, respectively) were higher for ALF than for SH100 and were increased ($P < 0.05$) by addition of 10 or 30% alfalfa to the soybean hull diet. Solid passage rates (4.1, 5.0, 4.2, 7.0, and 4.0%/h, SEM = 0.5, for SH100, SH90, SH80, SH70, and ALF, respectively) were highest ($P < 0.05$) for SH70. Positive associative effects were observed on both liquid and solid passage rates for SH70 ($P < 0.05$). Addition of 30% alfalfa to diets consisting primarily of soybean hulls led to positive associative effects on diet digestibility, but paradoxically increased liquid and solid passage rates.

Key Words: Soybean hulls, Digestion, Cattle

1191 Evaluation of various by-products for use in stocker cattle diets. D.L. Rankins, Jr.* and B.E. Gamble, *Auburn University, Auburn, AL.*

Two trials were conducted to evaluate various backgrounding diets for stocker steers. Both trials used crossbred steers for a period of 112 d. **Trial 1.** Fifty steers (initial BW 276 ± 15 kg) were allotted to one of five diets (5 steers/pen; 2 pens/diet). All diets were 53% cracked corn and 47% broiler litter (DM basis) fed free-choice with the following roughage sources offered free-choice: 1) bermudagrass hay (76% NDF, 36% ADF), 2) peanut hulls, 3) pelleted peanut hulls (74% NDF, 65% ADF), 4) cotton mote (81% NDF, 72% ADF) and 5) gin trash (57% NDF, 47% ADF). Total DMI was greater ($P < .05$) for steers fed hay and peanut hulls compared to those fed the other three roughage sources (12.9 and 13.3 kg versus 12.1, 11.6 and 11.9, respectively). Daily gains were fastest by steers fed the hay and peanut hulls (1.46 and 1.37 kg/d) and slowest for those fed the pelleted hulls and cotton mote (1.13 and 1.15 kg/d; $P < .05$). **Trial 2.** Fifty steers (initial BW 211 ± 12) were allotted to one of five diets (5 steers/pen; 2 pens/diet): 1) 53% cracked corn and 47% broiler litter, 2) 53% soyhull pellets and 47% litter, 3) 53% citrus pulp and 47% litter, 4) equal quantities of corn, soyhulls and citrus pulp to equal 53% and 47% broiler litter and 5) 55% corn and 45% peanut hulls. All diets were supplemented with free-choice bermudagrass hay. Total DMI was greatest for steers fed diets 1 and 5 (11.0 and 11.4 kg) and lowest for those fed diet 3 (8.6 kg; $P < .05$). Diets 2 and 4 were intermediate (10.7 and 10.1 kg). Daily gains were fastest for steers fed diets 1, 2 and 5 (1.21, 1.15 and 1.13 kg/d; $P < .05$) and slowest for steers fed diet 3 (.78 kg/d). Steers fed diet 4 gained 1.03 kg/d. When feeding a broiler litter-based diet, the supplemental roughage source should be selected based on ADF content. In litter-based diets corn and soyhulls are equivalent as an energy source; however, citrus pulp is not as effective.

Key Words: by-products, broiler litter, beef cattle

1192 In vitro mixed ruminal microorganism fermentation of whole cottonseed coated with gelatinized corn starch and urea. J. K. Bernard*¹, S. A. Martin², and T. C. Wedegaertner³, ¹The University of Georgia, Tifton, ²The University of Georgia, Athens, ³Cotton Incorporated, Cary, NC.

A replicated completely randomized design in vitro mixed ruminal microorganism fermentation study was conducted to determine the effect of coating whole cottonseed (WCS) with gelatinized corn starch and feed grade urea. Treatments were arranged as a 3 x 4 factorial to provide three levels of starch (0.0, 2.5, and 5.0%) and four levels of urea (0.0, 0.25, 0.5, and 1.0%). All treatments were prepared from one lot of WCS. Fermentations (40 mL) were conducted using medium that contained 20% (vol/vol) ruminal fluid in 160-ml serum bottles. Treated WCS was ground to pass through a 1-mm screen and weighed amounts (0, 0.4, 0.8, and 1.2 g) were added to the serum bottles. As starch increased, pH, hydrogen, methane, total VFA, and molar proportions of propionate (P) increased linearly ($P < 0.001$), whereas molar proportions of acetate (A) and A:P ratio decreased linearly ($P < 0.001$). Concentrations of L-lactate were highest ($P < 0.01$) with 2.5% starch compared to either 0 or 5.0%. As the amount of urea included in the coating increased, pH ($P < 0.001$) and methane ($P < 0.01$) increased linearly whereas hydrogen concentrations decreased linearly ($P < 0.05$). A quadratic response was observed for ammonia concentrations due to moderate increases with 0.25 and 0.5% additions and a greater increase with 1.0% urea (410, 442, 456, and 560 mg/L, respectively). Interactions ($P < 0.01$) among starch and urea were observed for hydrogen, methane, and L-lactate. Hydrogen and L-lactate concentrations decreased as urea increased with 0 and 2.5% starch, but increased with 5% starch. Methane concentrations increased as urea increased with 0 and 5% starch, but remained constant, except for an increase with 0.5% urea, for 2.5% starch. These

results indicate that coating WCS with up to 0.5% urea with gelatinized corn starch can potentially improve ruminal fermentation.

Key Words: Whole cottonseed, starch, urea

1193 Nutritive evaluation of a food industry byproduct for feedlot cattle. A. S. Bertin*, H. W. Harpster, V. H. Baumer, J. W. Comerford, and E. H. Cash, *The Pennsylvania State University, University Park.*

Bakery byproduct (BB), a recycled food industry waste consisting of 38% cookie, 29% bread and dough, 19% cake, 7% chips, and 7% pretzels, was evaluated as a replacement for corn in feedlot diets. Nutrient values (DM basis) were DM 93.1%; CP 12.0%; NDF 17.3%; ADF 4.7%; Ether Extract 9.5%; starch 48.9%; and ash 3.6%. Ten Angus crossbred and two Angus purebred yearling steers (404.13 kg) were blocked by weight and randomly allotted to three treatments (DM basis): 1. Control: 60% cracked corn (CC), 40% corn silage (CS) plus a vitamin/mineral mix providing 30 g/T monensin sodium (VMM); 2. BB: 60% BB, 40% CS + VMM; 3. Blend: 30% BB, 30% CC, 40% CS + VMM. Diets were individually fed in Calan[®] electronic doors. Steers were slaughtered based on a predetermined (ultrasound scan) external fatpoint of 1.0 cm (seven/treatment at 84 d; five/treatment at 112 d). One Blend steer was lost due to reasons unrelated to diet. There were no treatment X slaughter group interactions for any criteria ($P > .10$). Least-square means for the three respective diets were: DMI (kg/h/d) 11.70, 10.79, 11.79 (1 vs. 2 $P < .06$; 2 vs. 3 $P < .04$); ADG (kg/h) 1.82, 1.86, 2.06 (1 vs. 2 $P < .08$; 1 vs. 3 $P < .03$); and Gain/Feed .159, .178, .176 (1 vs. 2 $P < .01$; 1 vs. 3 $P < .02$). Mean external fat at slaughter was 1.16, 1.25, and 1.14 cm, respectively ($P > .10$). Respective least-square means (external fat as a continuous covariate) for treatments 1, 2, and 3 were: marbling, 502.4, 464.2, 494.4 (1 vs. 2 $P < .07$) (400 = slight; 500 = small); USDA quality grade, 18.58, 18.25, 18.54 (18 = high Select; 19 = low Choice); longissimus area (cm²), 82.50, 85.35, 83.74; kidney, pelvic, heart fat (%), 2.45, 2.46, 2.35; hot carcass weight (kg), 357.9, 355.6, 359.1; lean color, 2.57, 2.37, 2.41 (2 = light; 3 = ideal cherry red); and yield grade, 3.06, 2.91, 2.99. These data suggest that BB was equal to corn at a level of 60% in feedlot diets. Performance advantages were noted for the Blend diet, while carcass characteristics were similar among treatments.

Key Words: Byproduct, Beef, Carcass Characteristics

1194 Palatability of byproduct feeds and their effect on ruminal pH and carcass characteristics for meat goats. J.A. Moore, M.H. Poore, J.M. Luginbuhl, and M.E. Joyner, *North Carolina State University, Raleigh.*

Twenty-four crossbred wether goats (50% Boer, 6 per diet) averaging 27.4 kg at initiation of the study were fed either wheat midds (WM), soyhulls (SH), or corn gluten feed (CGF) at 1% of body weight along with orchardgrass hay (10.4% CP) offered to ad libitum consumption for 70 d. The control (hay) diet was supplemented with soybean meal to bring total dietary protein to 12.5% (5.7% soybean meal). Byproducts were brought to a 2:1 Ca:P ratio with limestone (corn gluten feed, 5.7%; wheat midds, 5.4% limestone) or dical (soyhulls, 0.7% dical and 12.8% soybean meal). Protein level of the byproduct feeds after minerals were added was: soyhulls, 17.3%; wheat midds, 16.6%; corn gluten feed, 21.9%. Goats readily consumed the byproduct feeds, which were offered 30 minutes prior to hay. Goats were fed individually in indoor raised pens and had trace-mineralized salt and automatic waterers. Initial weight ($P = .25$), final weight ($P = .48$), and average daily gain ($P = .56$) did not differ for the four treatments. Carcass weight was greatest ($P = .05$) for the SH goats (16.0 kg), intermediate for WM (15.6 kg) and CGF (15.3 kg), and lowest for control (14.5 kg) goats. Carcass grade did not differ ($P = .80$) and averaged 5.42 with a score of 5 being choice and 6 being choice-minus. Dressing percentage tended ($P = .12$) to be lower for the control goats (46.4%) as compared to SH (48.3%), CGF (48.3%), and WM (48.8%) diets. Ruminal pH by ruminocentesis 2.4 hr after feeding was highest ($P < .01$) for control goats (6.52) and lowest for WM goats (6.23) with SH (6.41) and CGF (6.35) being intermediate. In summary, goats readily ate the byproducts at 1% of body weight, and byproducts either had no effect (carcass grade, gain) or a positive effect (carcass weight, dressing percentage). Ruminal pH was lower for goats

fed the byproducts, but remained above 6. Soyhulls, corn gluten feed, and wheat midds appear to be viable feed supplements for meat goats.

Key Words: Byproducts, Goats

1195 Effects of solid passage rate, pH, and level of linoleic acid on the production of *cis*-9, *trans*-11-octadecadienoic acid (CLA) in continuous culture. X. Qiu*¹, M.L. Eastridge¹, K.E. Griswold², and J.L. Firkins¹, ¹*The Ohio State University, Columbus*, ²*Southern Illinois University, Carbondale.*

A dual-flow continuous culture system consisting of 4 fermentors was used in a 4 x 4 Latin square design. The 4 treatments were: 1) control = pH 6.5, 1% linoleic acid (LA), 4%/h solid dilution rate (SDR), 2) HSDR = pH 6.5, 1% LA, 8%/h SDR, 3) HLA = pH 6.5, 3% LA, 4%/h SDR, and 4) LPH = pH 5.8, 1% LA, 4%/h SDR. Inoculum was collected 6 h after feeding from a cow fed 40% alfalfa hay and 60% grain. The temperature was held at 39 + 0.1 °C, and liquid dilution rate at 0.12/h. Fermentors were continuously fed a diet (120 g/d DM) containing alfalfa hay (40%), corn (28%), and soybean hulls (26%). All diets except HLA contained 2% tallow. The LA was dissolved in buffer and continuously infused into the fermentors. Each period consisted of 10 d with the last 3 d for sample collection. The CLA content in outflow was lowest for control (0.14, 0.17, 0.20, and 0.21 mg/g DM, respectively). The CLA flows were 9.42, 10.92, 14.52, and 12.48 mg/d, respectively. The LPH increased CLA content, possibly by inhibiting biohydrogenation and bacteria growth. This was also reflected by a lower flow of stearic acid and higher flows of *trans*-18:1, oleic acid, and linoleic acid for LPH than control. The NDF and ADF digestibilities were not affected by pH. The HSDR increased CLA content, possibly because a shorter solid retention time lead to incomplete biohydrogenation. The OM, NDF, and ADF digestibilities and bacteria number were reduced by HSDR. With more LA available as a substrate for CLA, HLA resulted in a higher content and flow of CLA than control. The HLA resulted in the highest OM, NDF, and ADF digestibilities, biohydrogenation, and bacteria number. Continuous infusion of LA into the fermentors may have prevented any adverse effect on bacteria. *In vivo* data are needed to verify the effects of SDR, pH, and LA on CLA flow to the small intestine and incorporation of CLA into milk fat.

Key Words: Conjugated Linoleic Acid, Continuous Culture, Biohydrogenation

1196 Concentrations of conjugated linoleic acid in beef carcasses are not increased by supplementing a high-corn diet with 5.0% soybean oil. A.D. Beaulieu*, J.K. Drackley, N.R. Merchen, and E.L. Falkenstein, *University of Illinois, Urbana.*

Conjugated linoleic acid (CLA) has many beneficial effects including decreased tumor growth in animal models. Although CLA is formed in the rumen few data relate this synthesis to tissue concentrations. Our objective was to determine if supplementing a high-corn diet with soybean oil (SBO) increases the concentration of CLA in the rumen and tissues. Four rumen-cannulated steers were used in a Latin-square design with 28-d periods. A control diet (80% cracked corn, 2.0% corn steep liquor, 8.0% ground corn cobs, and 10% supplement) was supplemented with 2.5, 5.0, and 7.5% (DM) SBO. Supplementation with SBO did not affect rumen pH or VFA concentrations. The proportion and amount (mg FA/g DM rumen contents) of *cis*-9, *trans*-11 CLA (9,11 CLA) was not increased with increasing SBO. However, the proportion and amount of the *cis*-10, *trans*-12 (10, 12 CLA) isomer was increased ($P < 0.05$) by 5.0% and 7.5% SBO. *Trans*-C18:1 isomers in rumen contents were increased ($P < 0.05$) by 7.5% soybean oil. Proportions of *trans*-C18:1 isomers were correlated negatively ($P < 0.05$) with 9,11 CLA and positively ($P < 0.0001$) with 10,12 CLA. The control diet, supplemented with 0% or 5% SBO, was fed individually to 20 Angus-Waygu heifers for 90 d in a randomized design to determine the effect of SBO on tissue deposition of CLA. Supplementation with SBO did not affect feed intake, feed efficiency, or carcass quality. Tissue samples were obtained from the hind, loin, forequarter, liver, large and small intestines and subcutaneous, mesenteric, and perirenal adipose depots. The only CLA isomer identified in tissue extracts was 9,11; the concentration was greatest in subcutaneous adipose tissue but was not affected in any tissue by SBO. Supplementing high-corn diets with SBO does not increase CLA concentrations in tissues of fattening heifers. Research is needed to identify pathways of biohydrogenation that can account for

increased concentrations of 10, 12 CLA in rumen contents when high-oil diets are fed.

Key Words: Conjugated linoleic acid, Rumen fatty acids, Tissue fatty acids

1197 Effects of supplemental safflower seeds on conjugated linoleic acid in blood plasma, adipose tissue, and milk of primiparous beef heifers. J.D. Bottger*¹, D.L. Hixon¹, B.W. Hess¹, G.E. Moss¹, R.N. Funston², and D.C. Rule¹, ¹University of Wyoming, Laramie, ²USDA-ARS, Miles City, MT.

Thirty-six Angus x Gelbvieh primiparous heifers were used to determine effects of supplementing cracked safflower seeds on conjugated linoleic acid (CLA) and trans-vaccenic acid (TVA) in blood plasma, adipose tissue, and milk. Heifers were randomly assigned to one of three isocaloric and isonitrogenous treatments at parturition: cracked corn and soybean meal (C); cracked high-linoleate safflower seeds (L; 76% 18:2); or cracked high-oleate safflower seeds (O; 72% 18:1). Safflower supplements were formulated to provide 5% of intake as fat and all were individually fed at 0700 daily for 90 d starting 72 h postpartum. Heifers were provided ad libitum access to bromegrass hay. Adipose tissue biopsies were taken from the tailhead area 0, 45, and 90 d postpartum. Blood plasma was collected at 0, 30, 60, and 90 d postpartum, and milk samples were collected at 30, 60, and 90 d. Fatty acid profiles were determined by capillary GLC. Weight percentages of, TVA, 9c11t CLA, and 10c12c CLA were highest in milk of L-fed heifers at d 30, 60, and 90 ($P = .06$, $.04$, and $.02$, respectively). Treatment means for the L heifers were greatest ($P < .05$) for TVA (17.0%), 9c11t CLA (2.6%), 10c12t CLA (.02%), and 10c12c CLA (.09%). Treatment means for 9c11t CLA in adipose tissue were higher ($P < .05$) in L heifers (1.1%) than in C heifers (1.0%). Blood plasma TVA was highest ($P = .07$) in L heifers at d 30, 60, and 90. Heifers fed C had the greatest ($P < .01$) blood plasma weight percentage of 9c11t CLA at d 60 (.17%), with no differences at the other collection times. Heifers fed C had the highest blood plasma weight percentage of 10c12t CLA at d 60 and 90 ($P = .01$ and $.02$, respectively), but contained the lowest ($P = .03$) weight percentage of this fatty acid at d 90. We conclude that supplemental high-linoleate safflower seeds increased CLA in adipose tissue and milk, and increased TVA in milk and blood plasma of primiparous beef heifers.

Key Words: Conjugated Linoleic Acid, Safflower Seeds, Beef Heifers

1198 Dry matter intake is decreased more by abomasal infusion of unsaturated free fatty acids than by unsaturated triglycerides. J. K. Drackley, S. Thire, N. B. Litherland*, and A. D. Beaulieu, University of Illinois, Urbana.

Previous experiments from our group have demonstrated that abomasal infusion of unsaturated free fatty acids (FFA) markedly decreases DMI. In contrast, experiments from other groups have noted smaller decreases in DMI when unsaturated triglycerides (TG) were infused post-ruminally. Our hypothesis was that unsaturated FFA would be more potent inhibitors of DMI than an equivalent amount of unsaturated TG. Four Holstein cows were used in a single reversal design. Cows were fed a TMR (15.5% CP, 20.4% ADF) of (DM) 23% alfalfa silage, 23% corn silage, 40.3% ground shelled corn, and 10.5% soybean meal. Two cows received soy FFA (0, 200, 400, 600, 0 g/d) and two received soy oil (TG) in the same amounts; cows then were switched to the other lipid source. Cows were abomasally infused with each amount for 4-d periods. The daily amount of lipid was pulse-dosed in 4 equal portions at 0600, 1000, 1700, and 2200 h. No emulsifiers were used; infusions did not result in diarrhea. Both lipid sources linearly decreased DMI, with a significant interaction between lipid sources ($P < 0.01$). Slope-ratio analysis indicated that FFA were about 2.25 times more potent in decreasing DMI than were TG. Milk production decreased similarly to DMI. Milk fat content was increased linearly by lipid infusion. Milk fat yield decreased markedly for soy FFA infusion, but was relatively unaffected by infusion of TG (source by linear amount, $P < 0.01$). Contents of 4:0 and 6:0 in milk fat were unaffected by lipid infusions, but 8:0, 10:0, 12:0, 14:0, and 16:0 decreased as either infusate increased. Contents of 18:2 and 18:3 were increased linearly by abomasal infusion of either soy source; 18:1 (cis-9) was unaffected. Transfer of infused 18:2 to milk fat was 31, 37, and 24% for 200, 400, and 600 g/d of FFA and 34, 39, and 34% for TG. Unsaturated FFA reaching the abomasum decreased DMI to a greater extent than did infusion of an equivalent amount of

unsaturated TG, perhaps because of differences in release of intestinal hormones such as cholecystokinin (CCK).

Key Words: dry matter intake, free fatty acids, triglycerides

1199 The effects of organic chromium on glucose uptake and protein synthesis in primary fetal bovine muscle cells and glucose clearance of ruminants. G.V. Pollard*, J.L. Montgomery, T.C. Bramble, and C.R. Richardson, Texas Tech University, Lubbock.

The objective of this study was to evaluate the effects of organic chromium (Cr) on glucose metabolism and protein synthesis in ruminants. Glucose uptake and protein synthesis were conducted using serum from feedlot steers fed organic chromium diets, and glucose clearance was studied utilizing sheep as a model. One-hundred-five crossbred steers (283 kg) were fed typical finishing diets for 196 d and serum samples were collected via jugular venipuncture for *in vitro* glucose uptake and protein synthesis determination. Cultures of primary fetal bovine muscle cells were grown in RPMI media and 10% fetal bovine serum until 50% confluent. Protein synthesis and glucose uptake were measured as a percentage increase in dpm for serum treated cells over non-serum treated cells, utilizing [¹⁴C] labeled amino acid mixture and [³H] labeled glucose. Sixteen crossbred lambs were utilized for determination of glucose clearance following a 21 d feeding trial. To determine glucose clearance fasted sheep were challenged with 500 mg glucose/kg BW introduced via i.v. venipuncture and followed by collection of blood samples at -10, 0, 5, 10, 15, 20, 25, 30, 45, 60, 90, 120, and 150 min. Using a completely randomized design, treatments were: CON (0 ppb supplemental Cr), 200Cr (200 ppb Cr diet), and 400Cr (400 ppb Cr diet). Harvested serum from 200Cr and 400Cr increased ($P < .01$) protein synthesis in primary bovine muscle cells. Glucose uptake by muscle cells was increased ($P = .088$) by 200Cr and 400Cr serum in muscle cells. Glucose clearance was also improved by addition of Cr to the diet. These results suggest that carcass modifications in ruminants fed Cr containing diets are due to alterations in amino acid uptake and glucose metabolism within muscle cells.

Key Words: Chromium, Glucose, Feedlot Steers

1200 Influence of supplementing cobalt in the receiving ration on performance of heifers new to the feedlot environment. T. J. Wistuba, E. B. Kegley*, D. L. Galloway, and S. M. Williamson, University of Arkansas, Fayetteville.

Cobalt is an essential element in the formation of vitamin B₁₂ by microorganisms in the rumen. The cobalt requirement for cattle is currently 0.1 mg/kg. Vitamin B₁₂ enzymes synthesize one-carbon units, making it important in the metabolism of nucleic acids, proteins, carbohydrates, and lipids. Recent work has suggested that immune response is depressed in cobalt deficient cattle. The influence of dietary cobalt concentration on performance of growing heifers was studied using 86 crossbred heifers (211 ± 16.5 kg initial BW) in a 42-d receiving trial. Treatments consisted of a control diet that had an estimated cobalt concentration of 0.1 mg/kg of DM or an additional 0.1 mg of supplemental cobalt/kg of DM from cobalt carbonate. Heifers were allocated randomly within 8 weight blocks (16 pens) to treatment, with 6 heifers/pen in the lightest three blocks and 5 heifers/pen in the remaining blocks. Heifers were weighed on day 0, 7, 14, 28, and 42 and were observed daily for signs of clinical disease. For the entire 42-d study ADG (1.07 vs 1.01 kg), ADFI (6.22 vs 6.17 kg as fed) and gain/feed (0.17 vs 0.16) did not differ ($P > 0.10$) for the control heifers vs the heifers supplemented with cobalt, respectively. Supplemental cobalt did increase ADG ($P = 0.07$) and gain/feed ($P < 0.06$) from d 7 to 14. However, from d 14 to 28 control calves had increased ADG ($P = 0.09$) and gain/feed ($P = 0.07$). Percentage morbidity was not affected ($P > 0.10$) by supplemental cobalt (65%) vs control (76%), nor were medication costs, \$12.37 for cobalt supplemented calves vs \$12.57 for controls. Supplementing cobalt in the present study did not improve growth performance or lower medication costs for stressed calves.

Key Words: Cobalt, Cattle, Performance

1201 Effects of soybean oil and dietary copper on ruminal and tissue lipid metabolism in finishing steers. T. E. Engle^{*1}, J. W. Spears², V. Fellner², and J. Odle², ¹Colorado State University, Fort Collins, ²North Carolina State University, Raleigh.

An experiment was conducted to determine the effects of copper (Cu) and soybean oil (SBO) supplementation on ruminal and tissue lipid metabolism and carcass characteristics in finishing steers. Sixty Angus steers (369.0 ± 10.1 kg) were stratified by weight and randomly assigned to treatments in a 2 x 2 factorial arrangement with factors being 0 or 20 mg supplemental Cu/kg DM from Cu sulfate and 0 or 4% SBO. Steers were fed a high concentrate basal diet that contained 5.3 mg Cu/kg DM. Average daily gain and feed intake were reduced (P < .01) by SBO but were not affected by Cu. Gain:feed was not affected by treatment. Liver Cu concentrations were higher (P < .01) in steers receiving supplemental Cu and lower (P < .04) in SBO supplemented steers. Copper supplementation tended to reduce (P < .12) and SBO supplementation tended to increase (P < .11) serum cholesterol concentrations. Backfat depth was reduced (P < .10) by Cu and SBO supplementation. Longissimus muscle polyunsaturated fatty acids tended to be increased (P < .14) and the C18:1 trans isomer tended to be decreased (P < .12) in Cu-supplemented steers. Longissimus muscle C18-conjugated dienes and the C18:1 trans isomer were increased (P < .05) in SBO supplemented steers. Ruminal fluid C18:3 was increased (P < .05) and the C18:1 trans isomer was decreased (P < .05) in Cu supplemented steers. These results indicate that as little as 20 mg supplemental Cu/kg DM can reduce backfat, and may alter lipid metabolism in steers fed high concentrate diets.

Key Words: Copper, Steer, Fatty acid

1202 Metabolic responses of periparturient Holstein cows and heifers supplemented with chromium picolinate. B.T. Crochet^{*1}, C.C. Williams¹, L.D. Bunting¹, and J.M. Fernandez¹, ¹LSU Agricultural Center, Baton Rouge, LA.

Sixteen multiparous and 18 primiparous Holstein cows were used to determine the effects of supplemental chromium on carbohydrate and lipid metabolism during the transition period. From approximately 3 weeks prior to anticipated calving date until parturition, Cr treated cows were given 51 mg Cr picolinate via a gelatin capsule bolus three times weekly, equivalent to an average daily intake of 2 ppm Cr. Control cows were given empty gelatin capsules. All cows were fed total mixed rations, with one ration fed to dry cows, a second to lactating cows for the first week postpartum (transition), and a third to lactating cows thereafter. Blood samples were collected via jugular venipuncture at 1, 2, and 3 wk prior to anticipated calving date as well as immediately following calving, 3 d post calving, and 1, 2, and 3 wk post calving. Samples were analyzed for glucose, insulin, and NEFA. Within 1 wk prior to calving, an i.v. glucose tolerance test (IVGTT) was performed, and samples were analyzed for glucose and insulin. Plasma glucose response to the IVGTT was evaluated by calculating the half-life (T_{1/2}) and fractional turnover rate (k) for the period from 2 min to 19 min after glucose infusion. Supplemental Cr did not affect circulating concentrations of glucose, insulin, or NEFA (P > .10). Plasma NEFA concentrations were higher in primiparous cows (P < .01) throughout the experiment, with the difference being most apparent during the 3 wk postpartum. Glucose peaked higher at time of calving in primiparous cows (P = .07). The IVGTT revealed increased glucose clearance rate (P = .06) and a trend toward decreased glucose half-life (P < .10) in primiparous cows supplemented with Cr. Insulin peak concentrations were unaffected by treatment or parity (P > .10). Data suggest that Cr supplementation may alter carbohydrate metabolism in primiparous cows during the transition period.

Key Words: Transition cows, Chromium, Metabolism

1203 Interaction of dietary zinc and Synovex-H[®] on weight gain, carcass traits and zinc in tissues of growing beef heifers. M. Huerta^{*1}, R. L. Kincaid¹, J. R. Busboom¹, J. D. Cronrath¹, C. K. Swenson², and A. B. Johnson², ¹Washington State University, Pullman, ²Zinpro Corporation.

To examine the interactions of dietary Zn and growth implants, 60 beef heifers (379 kg BW) were randomly assigned to six treatments in a 2 x 3 factorial arrangement. The treatments were with or without Synovex-H[®] implants combined with either a control diet containing 40 ppm Zn or diets supplemented with an additional 200 ppm Zn from ZnSO₄ or

Zn-methionine (Zn Met; Zinpro Corp., Eden Prairie, MN). The heifers were fed for 120 d to determine ADG, followed by slaughter to collect carcass data. At d 50 the heifers were vaccinated with a modified live virus and subsequent titers against bovine viral diarrhea and concentrations of IgG were measured. Liver samples were obtained 7 d prior to the start of the experiment and on d 50 and 120. Blood samples were taken at d 0, 50, 74, 88 and 116. The data were analyzed by the GLM or mixed procedures of SAS for variables with a single measurement or with repeated measures, respectively. Means were compared with pre-planned orthogonal contrasts. Average daily gains were highest (P < .05) for non-implanted heifers fed Zn-Met. The percent of cattle that graded Choice was highest for the Zn-Met diet (70%), intermediate for the control diet (57%) and lowest for the ZnSO₄ diet (40%). Supplementation with Zn-Met increased (P < .05) the concentrations of Zn in serum, and the Synovex-H[®] implant reduced concentrations of Zn and Cu in liver at d 50. Antibody titers and concentrations of IgG in serum were highest (P < .05) in heifers fed ZnSO₄ compared to heifers fed the control or Zn-Met supplemented diets. The results of this study indicate both the level and source of Zn supplementation in diets of feedlot heifers affect their response to growth implants.

Key Words: Zinc, Heifers, Growth Implants

1204 Effect of supplemental copper on copper status, serum cholesterol and milk fatty acids in Holstein cows. T.E. Engle, V. Fellner^{*}, and J.W. Spears, North Carolina State University, Raleigh.

Twenty four lactating Holstein cows were fed corn silage based diets to determine the effects of dietary copper (Cu) on liver and plasma copper concentrations and lipid metabolism. Sets of 3 cows closest in age, days in milk, milk yield and parity were separated into 3 groups with 8 cows per group. Cows were housed in free-stalls and fed individually with the aid of Calan gates; experimental diets were fed for a total of 61 days. Each group was randomly assigned to one of three treatments: 1) control 8.9 mg Cu/kg of basal diet (no supplemental Cu), 2) 10 mg of supplemental Cu/kg DM, and 3) 40 mg of supplemental Cu/kg DM; the source of Cu was CuSO₄. At the end of 61 d, liver Cu concentrations were higher (P < .01) in cows receiving supplemental Cu compared with the control group; cows fed 40 mg Cu/kg DM had higher liver Cu concentrations (826 mg/kg of DM vs 431 mg/kg of DM) than cows fed 10 mg Cu/kg DM. Plasma Cu concentrations were similar across all treatments. Feeding supplemental Cu resulted in an increase (P < .05) in total serum cholesterol concentrations with the levels being highest for cows receiving 40 mg Cu/kg DM. Dry matter intake, milk yield, and milk composition were not affected by treatment. Concentrations of C18:1 trans isomer and total C18-conjugated dienes in the milk were lower (P < .05) in cows receiving supplemental Cu compared to the non-supplemented controls. Feeding 10 mg of supplemental Cu/kg DM resulted in a higher (P < .01) C18:2 and total polyunsaturated fatty acid content in milk. These results indicate that Cu can alter lipid metabolism in high producing dairy cows and Cu supplementation at 40 mg/kg DM for 61 d significantly increases liver Cu concentrations to marginally toxic levels.

Key Words: Copper, Dairy Cows, Milk lipids

1205 Stability in the rumen of protected vitamin A measured by nylon bag technique. J.C. Robert, G. Dumont, and S. Bourdeau, *Aventis Animal Nutrition, Antony, France.*

This experiment was designed to study the release in the rumen of vitamin A from encapsulation (Microvit A, I.U./g 500.000 - Aventis Animal Nutrition) originally used to guarantee stability during pre-mixes and compound feed manufacturing. A cross over experimental design was used with 2 periods of ten days each, 2 different types of ration and 2 cows per type of ration. The two rations were constituted : % D.M. (H) : hay 70, cereals 20, SBM 10 and (CS) : corn silage 82, SBM 6.0, hay 12. Quantities distributed were 8 kg per animal per day with two meals. Adapted nylon bag technique was used with 2.2 x 2.5 cm nylon bag size (internal), pore size : 48µ and 253 mg Microvit A introduced to get weight to surface exchange : 23 mg/cm². Nylon bags were incubated 3, 6, 12, 18, 24, 36 and 48 hours. After incubation nylon bags were gently washed with cold water and the vitamin A content determined by spectrophotometry at wavelength 325 nm after saponification with alcoholic potassium hydroxide and extraction with hexane. The results

desmonstrate the good stability of the encapsulation process in the rumen for rumen retention time up to 12 hours corresponding to standard figures for lactating dairy cows. Resistance of the encapsulation [% resistance : (vitamin A in nylon bag at times 3, 6, 12, 18, 24, 48/vitamin A in nylon bag at time 0) x 100] was significantly lower with H compared to CS. This could be due to rumen pH differences with conditions more or less favorable for the solubilisation of the encapsulation material.

Vitamin A encapsulation : % rumen resistance:

Incubation times (h)	3	6	12	18	24	36	48
Ration : H	89 ^a	87 ^a	76 ^a	55 ^a	42 ^A	18 ^A	12 ^A
CS	88 ^a	89 ^a	88 ^b	82 ^b	76 ^B	61 ^B	50 ^B
SED	4.2	4.1	6.3	9.9	8.5	12.7	11.3

* a, b, A, B : means in the same row with different superscripts are significantly different (a,b : p<0.05 - A,B : p<0.01)

Key Words: ruminant, vitamin A, rumen stability

1206 Liver storage of vitamin A as a function of elevated dietary supply in ruminants. J.C. Robert, G. Dumont, and A. Motte, *Aventis Animal Nutrition, Antony, France.*

This experiment was designed to study the effect of increasing levels of ingested vitamin A on liver storage of vitamin A in ruminants. Trial was carried out during 90 days on 90 early weaned ruminant lambs, 3 months of age, weight 12 kg at start of trial. Ration fed : straw (50 g/anl/day), concentrate ad libitum, composed of (% D.M.) : barley (45), wheat (22), SBM (8), wheat bran (12), palm kernel meal (8), ammonium chloride (1) and a mineral vitamin premix with or without vitamin A (4). Experimental design was block x treatment (15 x 6) ; the six treatments were 6 levels of vitamin A supplementation, using Microvit A (750.000 IU/g, Aventis Animal Nutrition) measured in I.U./g concentrate : T1 : 0 (control) ; T2 : 20, T3 : 40, T4 : 60, T5 : 80, T6 : 100. Vitamin A concentrations in concentrates were measured by the Carr Price method. Individual concentrate quantities ingested were measured. At slaughter, livers were collected, weighed and frozen. After defreezing, vitamin A concentration was dosed by spectrophotometry on an aliquot of total liver after grinding and homogenisation. Liver storage ratio [(I.U. vitamin A in the liver/I.U. ingested vitamin A) x 100 after taking the basal line into account through control values] was around 30 % for a supplementation of 20 I.U./g feed. Liver storage ratios were reduced, when levels of supplementation were increased. This could be due to saturation either of the intestinal absorption pathway or the liver's capacity to store vitamin A or a combination of the two.

Diets	T1	T2	T3	T4	T5	T6	SED
Vit. A in feed IU/g	2.4	19.8	45.6	61.3	83.1	109.2	
Vit. A intake IU/anl x 10(3)	186 ^{aA}	1.680 ^{bB}	4.036 ^{cC}	5.141 ^{dD}	7.200 ^{eE}	9.844 ^{fF}	224
Tot. liver storage IU x 10(3)	11 ^{aA}	522 ^{bB}	967 ^{cC}	928 ^{cC}	898 ^{cC}	999 ^{cC}	81
Liver stor. ratio %	-	34.1 ^{aA}	25.0 ^{bB}	18.9 ^{cC}	12.1 ^{dD}	10.1 ^{dD}	1.9

* a, b, c, ..., A, B, C, ... : means in the same line with different superscripts are significantly different (a,b, ... : p<0.05 - A,B, ... : p<0.01)

Key Words: ruminant, vitamin A, liver storage

1207 Starch source affects phosphorus digestion and excretion by lactating dairy cows. A.D. Guyton^{*1}, K.F. Knowlton^{1,5}, D.P. Casper^{2,5}, B.P. Glenn^{3,5}, and V.A. Wilkerson^{4,5}, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²Agri-King, Inc., Fulton, IL, ³Federation of Animal Science Societies, Bethesda, MD, ⁴Land O'Lakes, Inc., Denver, CO, ⁵Formerly at USDA-ARS, Beltsville, MD.

The objective of this study was to evaluate the effects of forage type and starch source on P excretion using samples from previously reported digestion experiments. Preliminary results from one study indicated that

replacing dry corn with high moisture corn reduced P excretion. To evaluate this, feed, feces, and urine samples from four digestion trials were analyzed for total P. Two experiments (14 cows, 54 observations) compared high moisture (HM) and dry (D) corn, either ground (G) or rolled (R) in a 2x2 factorial arrangement of treatments. As previously reported, ruminal and total tract starch digestibility and NEL content were increased with HM vs. D, and with G vs. R. High moisture corn tended to increase P availability (33.8 vs. 29.9%, P < .11) vs. D. Phosphorus balance was numerically greater with HM vs. D (7.2 vs. 1.8, P < .18). Grinding corn had no effect on P digestion or retention. Two experiments (8 cows; 32 observations) compared orchardgrass (OG) and alfalfa (A) silage, and dry ground barley (B) and dry ground corn (C) in a 2x2 factorial arrangement of treatments. In these studies C increased total tract starch and NSC digestibility vs. B (data previously reported). Corn increased apparent P digestibility vs. B (36.3 vs. 26.5%; P < .01) and increased P balance (13.3 vs. 1.1 g/d; P < .03) vs. B. Although dry matter and fiber digestibility were higher for OG than for A (previously reported), forage type had no effect on apparent P digestibility or P balance. In four digestion experiments, more digestible dietary starch sources (HM corn vs dry, or corn vs. barley) decreased fecal P excretion as a percent of P intake, most likely due to improved availability of dietary P.

Key Words: Phosphorus Excretion, Starch Digestibility, Lactating Cows

1208 Automated system for collection of ruminal fluid and blood of ruminants. M. S. Allen*, M. Oba, and C. S. Mooney, *Michigan State University, East Lansing, MI.*

A system was developed to collect samples of ruminal fluid and blood during feeding behavior studies at periodic intervals or at times triggered by animal responses such as eating and ruminating. A computer program controls one peristaltic pump and fraction collector for each group of up to four animals for collection of ruminal fluid or blood. For ruminal fluid collection, Tygon[®] tubing (1.6 mm i.d., 7.5 m length, 14.8 ml void volume), protected within the rumen by a 60 cm length of milk line tubing (1.6 cm i.d.) is inserted through a ruminal cannula. Filtered ruminal fluid is withdrawn from a reservoir (5.7 cm diameter perforated rubber ball) covered with a 10 cm x 20 cm dacron bag with 53 μm pore size. The reservoir is weighted to remain in the ventral rumen and vented to prevent negative pressure following ruminal contractions. Ruminal fluid within the tubing is voided into a waste container before sample collection. Blood is collected via catheter and Tygon[®] silicone tubing (1.6 mm i.d., 7.5 m length, 14.8 ml void volume) which is autoclaved before use. Blood is completely flushed from tubing with saline containing heparin (10 USP units/ml) after sampling to prevent coagulation. This process requires a reversible pump and pinch valve to divert blood and anticoagulant. The solution containing anticoagulant as well as contaminated blood are completely flushed from the system into a waste container. The criterion used to determine pumping time required to flush all contaminated blood was restoration of hematocrit. The system was evaluated in a duplicated 4x4 Latin square experiment in which two 7.5 ml samples of ruminal fluid and blood were collected every 20 min for 24 h per period from each cow. The system successfully collected 97.9% and 99.5% of the total samples for ruminal fluid and blood, respectively (4,608 samples each). This system allows blood and ruminal fluid measurements to be related to feeding behavior that is recorded simultaneously.

Key Words: Blood collection, Rumen fluid collection, Feeding behavior

1209 Diurnal variation in ruminal parameters of lactating dairy cows fed diets varying in fermentability.. M. Oba* and M. S. Allen, *Michigan State University, East Lansing, MI.*

Diurnal variation in ruminal pH and VFA concentrations were evaluated for cows fed diets varying in fermentability. Eight multiparous ruminally and duodenally cannulated lactating Holstein cows (55 ±15.9 DIM; Mean ±SD) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Experimental diets contained either ground high moisture corn (HM) or dry ground corn (DG) at two dietary starch contents (32 vs. 21%). Diets were fed once daily as TMR and cows were housed in tie-stalls. Ruminal fluid was collected every 20 min for 24 h, and ruminal pH was monitored with a computerized data acquisition system. Although true ruminally fermented OM was greater for HM compared to DG both in high starch

diets (11.3 vs. 10.3 kg/d) and low starch diets (9.3 vs. 7.7 kg/d), most ruminal parameters were not affected by conservation method of corn grain. High starch diets reduced daily mean ruminal pH (6.13 vs. 6.29) and increased daily variation range for ruminal pH (± 0.60 vs. ± 0.53) compared to low starch diets. Although the highest correlation between single time-point samples and minimum daily ruminal pH was observed 4 h after feeding, the 95% CI for predicted minimum daily ruminal pH was ± 0.41 pH. Daily mean and daily variation range (95% CI) for acetate content were not affected by treatment, averaging 60.4 and ± 24.1 mM, respectively. High starch diets increased daily mean for propionate content (26.7 vs. 21.6 mM), and its daily variation range (± 13.8 vs. ± 10.2 mM) compared to low starch diets. Daily minimum propionate content was not affected by treatments, averaging 12.1 mM. However, daily maximum propionate content was greater for high starch diets compared to low starch diets (40.4 vs. 31.7 mM). High starch diets decreased daily mean acetate to propionate ratio (APR; 2.45 vs. 2.97) and daily variation range for APR (± 0.52 vs. ± 0.69) compared to low starch diets. These observations suggest that large diurnal variations exist for ruminal parameters and experimental results based on infrequent sampling of ruminal fluid must be used with caution.

Key Words: VFA, Ruminal pH, Diurnal variation

1210 The effect of protein and energy supplement added to a basal diet fed in 2 or 7 meals daily on milk yield and urinary excretion of purine derivatives. M.C. Thivierge^{*1}, J.F. Bernier¹, and H. Lapierre², ¹Universite Laval, QC, Canada, ²Dairy and Swine R & D Center, Lennoxville, QC, Canada.

Increasing feeding frequency (FF) stabilises conditions in the rumen that could result in increased microbial protein synthesis, making cows less responsive to rumen-undegradable protein (RUP) and energy supplement (P&E). Therefore, the effect of a P&E supplement fed 7 times per day and added to a basal TMR fed in 2 or 7 meals/d was investigated using 8 Holstein cows in a 2 x 2 factorial arrangement using a replicated 4 x 4 Latin square design with 14-d experimental periods. The P&E supplement corresponded to 0 or 1.83 kg of Pro-Lak[®] (76% CP; 53% RUP, H.J. Baker & Bro., Inc.) + 1 kg of dry molasses. The TMR provided 71% CP, 90% rumen-degradable protein, 54% RUP, and 96% of NE_L daily requirements. The TMR intake was restricted to 95% of previous ad libitum intake, to insure similar intake among FF. Milk yield components and urinary excretion of purine derivatives (PD: allantoin + uric acid) were measured over the last 3 d of each experimental period. Milk yield increased with P&E supply but this increment was similar for the two FF. Crude protein yield increased by 4% with increasing FF and by 12% with the P&E supplement. Globally excreted urinary PD, an index of microbial protein synthesis, were not affected by treatments. Although increasing FF tended to increase milk and protein yield, it did not affect the response of the cows to P&E supplement and the excretion of PD.

FF:	2	meals	7	meals	Con	trast	(P)
					SEM	FF	FFx
P&E supply:	-	+	-	+		P&E	P&E
TMR intake;							
kg/d	19.6	19.4	19.5	19.2	0.15	0.29	0.18
Milk							
Yield;							
kg/d	26.8	30.1	27.7	30.9	0.46	0.11	≤0.01
CP yield;							
g/d	850.1	969.8	899.5	997.7	18.8	0.06	≤0.01
Urinary;							
mmol/d							
Allantoin	271.3	244.9	261.3	236.1	16.1	0.57	0.13
Uric acid	37.5	42.6	34.5	36.6	2.0	0.04	0.09
PD	308.8	287.5	295.9	272.7	17.0	0.43	0.21

Key Words: Cows, Feeding frequency, Purine derivatives

1211 The role of pH in regulating ammonia production by mixed ruminal bacteria. L. T. Cunha, R. P. Lana*, A. C. Borges, and J. S. Oliveira, Universidade Federal de Vicosa, Vicosa-MG, Brazil.

This research evaluated the pH effect by adding increasing levels of corn starch in deamination and growth of mixed ruminal bacteria. The rumen fluid was taken from a fistulated steer in a 40 percent concentrate diet, and centrifuged at 500xg in 15 minutes to remove feed particles and protozoa. The incubations were done in an anaerobic environment at 39°C. It was used 150 mg of tripticase and 0, 25, 50, 75, 100, 200 and 300 mg of corn starch in 10 mL rumen fluid. Samples were collected over the incubations and the pH measured. After that, the samples were centrifuged at 5200xg in 10 minutes and the supernatant was frozen for ammonia determination. The pellets were washed in a 0.9 percent saline solution for microbial protein determination. The starch had small effect on microbial growth, but levels of 50 mg/10 mL or greater inhibited completely the ammonia production. The inhibition was probably due to pH effect, once that it showed higher correlation with ammonia production than the starch (0.95 versus -0.59). Because the largest amount of the utilized tripticase was for ammonia production, and it was highly inhibited by acidity, mild decrease in ruminal pH by concentrate utilization can be useful to reduce losses of food protein by ruminal fermentation. This means that when higher level of starch is added to the ration, greater amount of degradable protein can be added to the ration, without increasing losses of protein as ruminal ammonia.

Key Words: Ammonia, pH, Rumen

1212 A comparison of filter bag methods with conventional tube methods of determining the in vitro digestibility of forages. D. Wilman and A. Adesogan, IRS, University of Wales, Aberystwyth, UK.

In vitro digestibility of forages is commonly estimated by two-stage methods in which the various samples are kept completely separate from one another, using tubes. A possible alternative approach, which may save labour, is to use larger vessels, within which up to as many as 25 samples are incubated, each contained in its own filter bag. The two approaches were compared for estimating apparent dry matter (DM) digestibility, apparent digestible organic matter in DM, true DM digestibility, true digestible organic matter in DM and digestibility of neutral detergent fibre. The forage samples analysed comprised all 72 combinations of two forage species (Lolium multiflorum and Medicago sativa), three plant parts (whole crop, leaf and stem), three degrees of particle breakdown (0.5, 1.0 and 1.5 mm sieve size when milling) and four field replicates. Rumen fluid from sheep was used for two field replicates and rumen fluid from cattle for the other two. There was no discernible effect on digestibility of the sieve size used when milling, e.g. true digestible organic matter in dry matter using filter bags was 674, 677 and 663 g kg⁻¹, respectively, (SE 6.4) with the 0.5, 1.0 and 1.5 mm sieves. There were smaller differences between the two forage species (in respect of whole crop, stem and leaf) with the filter bag than with the tube method. The standard errors and coefficients of variation were higher with the filter bag than with the tube method; of 16 coefficients of variation calculated for each method, the mean with filter bags was 4.0 % and the mean with tubes was 2.7 %. Linear regression indicated that true and apparent digestibility in tubes were accurately predicted by the respective estimates from filter bags. However, true digestibility was predicted more precisely (r^2 0.92 – 0.95) than apparent digestibility (r^2 0.83 – 0.91). Forage digestibility estimates obtained using rumen fluid from sheep were very similar to those obtained when cattle rumen fluid was used. It is concluded that the traditional tube methods gave more precise estimates than the filter bag methods. However, the lower labour input of the filter bag methods suggests that they are more attractive for routine analysis.

Key Words: In vitro, Digestibility, Silage

1213 Estimating digestibility from measurements of fermentation by rumen microorganisms in dual-flow continuous cultures. J-S. Eun* and V. Fellner, North Carolina State University, Raleigh.

Rumen microbial populations incubated in dual-flow continuous cultures received diets with three forage to concentrate ratios (70:30; 50:50, and 30:70). Forage consisted of pelleted alfalfa and the concentrate mix

included ground corn and soybean meal. The nominal volume of the culture vessels was 700 ml and saliva was infused continuously at .73 ml/min resulting in a fractional dilution rate of 6.3 %/h. Actual measurements of short chain fatty acid concentrations and methane output were used to compute stoichiometric estimates of digestibility. Total short chain fatty acid production averaged 65 mmol/L/d and was not affected by level of concentrate in the diet. Acetate production increased from 2.2 mmol/g of dry matter intake to 2.6 mmol/g of dry matter intake and propionate decreased from 1.6 mmol/g of dry matter intake to 1.2 mmol/g of dry matter intake with an increase in the forage to concentrate ratio; there was no effect of diet on rate of butyrate production which averaged 0.5 mmol/g of dry matter intake. Methane output by ruminal cultures receiving the high forage diet averaged 948 nmol/ml and declined by 16 % and 43 % as the amount of concentrate increased to 50 % and 70 %, respectively. Based on the total substrate used for short chain fatty acid production, apparent digestibilities averaged 30 % across all treatments. Including the amount of substrate used for gas production would increase estimates of digestibility. Total short chain fatty acid production and methane output were much lower when compared to in vivo numbers but accounting for the total dry matter intake resulted in estimates that were remarkably similar to those observed in vivo. Microbial fermentation in dual-flow continuous culture systems is a reliable model to simulate in vivo conditions. Results are discussed with reference to specific constraints that may impact fermentation within the ruminal cultures

Key Words: Dual-flow continuous cultures, Digestibility, Short chain fatty acid production

1214 In vitro culture of *Entodinium exiguum* and *E. caudatum*, with or without rumen bacteria. M. Fondevila*¹ and B.A. Dehority², ¹University of Zaragoza, Zaragoza, Spain, ²Ohio State University, Wooster.

Two rumen amylolytic protozoa, *Entodinium exiguum* (EE) and *E. caudatum* (EC), were cultured with or without antibiotics, to evaluate if their dependence on living bacteria for growth would affect short term incubations. The protozoa were isolated from sheep rumen contents, cultivated in medium M (Dehority, 1998. J. Anim. Sci., 76:1189-1196), and fed 0.1 ml of a 1.5% wheat and 1.0% orchardgrass suspension daily. In preliminary studies with EE, the addition of antibiotics (2000 U penicillin and 130 U streptomycin per ml of medium) reduced bacterial concentrations by over 99% in 4h and essentially removed them entirely after 8h. In contrast, protozoal concentrations increased (107 ±5.6, 122 ±5.2 and 208 ±14.4 % after 4, 8 and 24h), indicating they were apparently not affected. Generation time after 24h was 23.3 ±1.97h. In the principal study, treatments were: protozoa plus antibiotics (PA), PA plus autoclaved bacteria (PAB) or protozoa plus living bacteria (PLB). Two tubes per treatment were inoculated with either EE or EC, fed daily, and sampled at 12, 24, 48, 72 and 96h. Inoculum for treatments PA and PAB was pre-incubated 4h with antibiotics. Generation time after 24h was shorter for EE (22.8h) than for EC (31.0h; P<0.05); however, no differences were found at later sampling times (P>0.10). In both species, concentrations (as a % of initial concentration) were unaffected by the absence of bacteria up to 48h. At 72 h in EE, PLB was higher than either PA or PAB (620, 300 and 342 %, respectively; P<0.05), but no difference was observed for EC at 72h. After 96h, there were differences in growth of EE between PLB and PA and PAB (P<0.01), but differences between PLB and PAB were not significant in EC (1214, 236 and 442 % in EE, and 740, 398 and 487 % in EC, for PLB, PA and PAB). The need for rumen bacteria in EE is manifested in culture periods longer than 48h and in EC after 72h. Differences between PAB and PA, though non significant, might indicate an effect related to a nutritive contribution by the bacteria.

Key Words: rumen Protozoa, In vitro culture, presence of bacteria

1215 Total purines as a bacterial marker: comparison of two procedures. C. J. Fu* and M. S. Kerley, University of Missouri, Columbia.

Two procedures for measuring total purine content of mixed ruminal bacteria (MRB) were compared. Samples were from a continuous culture study which was designed to determine the effect of monensin on microbial protein requirements. The basal diets were corn and casein. The isolated bacteria and effluent were freeze-dried and stored at 4°C. The classic procedure was published by Zinn and Owens in 1986 (J.

Anim. Sci. 66:157-166). This procedure utilizes 0.5 N HCl as the blank in reading absorbance. The standards are RNA from torula yeast. The purine precipitation of the samples and standards are washed by H₂SO₄ (pH2) solution before reading absorbance at 260nm. The new procedure utilizes 0.5 N HCl and adenine and guanine solution as the blank and standard, respectively. The purine precipitate of samples and standards are washed by precipitation solution instead of H₂SO₄ solution because the authors believe that H₂SO₄ solution can potentially wash out purines (primarily adenine) and result in overestimating microbial nitrogen flow out of the rumen. The precipitation solutions are composed of (per 100ml) 0.625ml 11.7 M HClO₄ in 4.375 ml 0.0285M NH₄H₂PO₄, 5.0 ml 0.4M AgNO₃, and 90.0 ml 0.2M NH₄H₂PO₄. The results indicated that total purine content (% of DM) and purine:nitrogen ratio, in bacteria and effluent residues, are significantly higher (P<.01) using the classic procedure than that measured using the new procedure. However, the percentage of bacterial nitrogen in effluent nitrogen, bacterial nitrogen production, and microbial growth efficiency were not affected by the analysis method. We concluded that it is feasible to employ the classic procedure to determine the total purine content and to use it as bacterial marker for estimating bacterial growth and efficiency. °

Key Words: Bacterial marker, Purine, Precipitate

1216 Evaluation of Primary Rumen Epithelial Cell Culture Techniques in Sheep. R.C. Gillis*¹, J.L. Klotz¹, R.L. Baldwin, VI², and R.N. Heitmann¹, ¹The University of Tennessee, Knoxville, ²USDA/ARS, Beltsville, MD.

Objectives of this study were to determine if number of cells incubated in primary rumen epithelial cell cultures affects production rates of metabolites and to standardize reporting criteria by obtaining an optimum mode of data expression. Epithelial tissue was excised from 5 Suffolk Dorset crossbred sheep and subjected to serial tryptic digestion to isolate cells. Isolated cells were incubated for 90-minutes in 25 mM propionate and 10 mM butyrate at concentrations of .5, 1, 5, 10, 20 and 40-million cells per flask (total vol. = 3ml). Production of acetoacetate (ACAC), β -hydroxybutyrate (β HBA), lactate (LAC) and pyruvate (PYR) were measured. Data were expressed as either cell number, cell dry matter or cell total protein alone or per epithelial wet tissue weight, body weight (BW) or metabolic BW to generate twelve different forms of data expression. Coefficients of variation were calculated for all 12 modes of expression. Expressing data per cell number resulted in the lowest variation (P < .05) and data adjusted for metabolic BW had less variation than BW. ACAC concentrations were largest at .5-million cells/flask (P < .05) and there were no differences between 1, 5, 10 and 20 and only 40 differed from .5 and 5-million cells/flask. β HBA concentrations were largest at 1 and 5-million cells/flask. However, 1 and 5 only differed significantly (P < .05) from 20 and 40-million cells/flask. LAC and PYR concentrations were largest at 1-million cells/flask, but no significant differences were found. β HBA:ACAC ratios were below one for .5 and 1-million cells/flask indicating low mitochondrial redox potentials (P < .05). A suggested range of rumen epithelial cells to include in incubations is 5 to 20-million/flask. This range will minimize the potential for altered metabolite production caused by incubating large cell quantities as well as the experimental error associated with using low cell numbers. When rumen tissue is taken from animals of the same species, size and stage of development, data adjusted by cell number are preferred.

Key Words: Rumen Mucosa, Cell Culture, Sheep

1217 Comparison of three methods for determining proteolytic activity of ruminal fluid. A. N. Hristov*¹, T. A. McAllister², Z. Xu², and C. J. Newbold³, ¹Department of Animal and Veterinary Sci., University of Idaho, Moscow, ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB, Canada, ³Rowett Research Institute, Aberdeen AB, UK.

A novel method for determining proteolytic activity (PA) of ruminal fluid utilizing ¹⁵N-labeled casein was compared to two published procedures. Four heifers were fed two isonitrogenous diets containing (on a DM basis): 49.5% barley silage; 45.2% rolled barley grain; and 5.3% soybean meal (HF) or 8% barley silage; 88% rolled barley grain; and 5.3% soybean meal (HG) in a cross-over arrangement. Rumen fluid was analyzed either fresh (FSH) or after being frozen at -40°C for 45 days (FRZ). The PA methods tested differed in substrate preparation: ¹⁵N-labeled casein (15N, produced via infusion of (¹⁵NH)₂SO₄ into the

rumen of a lactating dairy cow), ^{14}C -labeled casein (14C, Rowett Research Institute), and Azocasein (AZO, Sigma Chem. Co.). Incubations were carried out for 20 min at 39°C in 0.2 M phosphate buffer (pH 6.8). PA for the 15N method was estimated by three approaches: as N soluble in 5% trichloroacetic acid (TCA), as N soluble in 5% TCA corrected for microbial N uptake (TCAM) and as N depleted from the soluble protein N pool (SOLPR). Proteolytic activity in 14C and AZO was determined as TCA soluble radioactivity or dye (respectively) released during the incubation. Across treatments, the highest ($P < 0.001$) proteolytic activity was measured by the SOLPR method (averaged 14.9) followed by TCAM (11.0), TCA (7.9) and 14C (6.5) with the lowest activity being associated with the AZO method (2.0 mg N released per ml rumen fluid per min). Within the 15N and 14C methods, HG and FRZ rumen fluid had higher ($P < 0.05$) proteolytic activity as compared to HF and FSH, respectively. Similar results between the 15N and 14C methods demonstrates that the proposed 15N method can be successfully used to measure proteolytic activity of ruminal fluid. Increasing the proportion of grain in the diet and freezing was found to increase the proteolytic activity of the rumen fluid.

Key Words: Rumen, Proteolytic Activity, Methods

1218 Assessing the potential of stable carbon and nitrogen isotopes at natural abundance levels for measuring rumen microbial attachment to corn silage. J. G. Andrae¹, C. W. Hunt¹, K. A. Johnson*², and J. Marshall¹, ¹University of Idaho, Moscow, ²Washington State University, Pullman.

Plants that utilize C_3 and C_4 photosynthetic pathways have different stable carbon isotope ratios ($^{13}\text{C}:^{12}\text{C}$; δC). Nitrogen ratios ($^{15}\text{N}:^{14}\text{N}$, δN) may also differ between feeds as a result of fertilization regimes. The objective of this study was to determine if natural levels of δC and δN could be used to label ruminal microbes and measure their attachment to corn silage. Two ruminally cannulated cows were fed a C_3 diet of 45% barley and 55% alfalfa hay for 21 d prior to in situ incubation of duplicate samples of unprocessed and mechanically processed (rolled) corn silage. Corn silage was not further processed (i.e. dried or ground) prior to incubation. Silage samples were weighed into 25 x 30 cm dacron bags and ruminally incubated for 0, 1, 2, 3, 6, 12, or 24 h. Following incubation, samples were analyzed using mass spectrometry. Processed and unprocessed residue responses to time were assessed using simple linear regression, and subsequently compared using dummy variable regression techniques. Isotope ratios from ruminal microbes isolated immediately prior to in situ bag insertion were similar to the diet (-26.97 δC and 3.32 δN). Unincubated corn silage samples had δC typical of C_4 plants (-11.75) and high δN (8.50) values. δN and δC of residues showed a significant linear decrease ($P < .05$) across time, which we suggest represents microbial attachment. Slopes of δN differed ($P < .05$) for processed and unprocessed silage suggesting processed silage was more rapidly colonized by bacteria than unprocessed silage. Carbon ratios responded similarly; however, increased variability during early incubation times prevented the statistical detection of differences between silage types. Natural abundance levels of stable nitrogen isotopes may be useful for measuring rumen microbial attachment to corn silage. Similar carbon isotope results suggest this isotope may also be useful in measuring attachment, but variability between samples must be controlled.

Key Words: bacteria, attachment, silage

1219 Methane oxidation in the rumen. H. Kajikawa*¹ and C. J. Newbold², ¹National Institute of Animal Industry, Tsukuba, Japan, ²Rowett Research Institute, Aberdeen, UK.

The reduction of methane generated from the ruminal fermentation could contribute the economical and ecological benefits because it is an emission of a greenhouse gas as well as loss of dietary energy. Methane oxidation, which has been reported for many aerobic and anaerobic environments, is not known to occur in the rumen. This study was done to investigate the extent of methane oxidation in the rumen, and identify the electron acceptor for that oxidation, if occurred. The ruminal fluid was taken from three ruminally fistulated Suffolk sheep before morning feed. After being mixed and diluted three-fold with a buffer, the ruminal fluid (30 ml) was incubated in a glass bottle with 10 ml of $^{13}\text{CH}_4$ or $^{12}\text{CH}_4$ gas at 39°C, balancing the remaining headspace gas with CO_2 . The extent of methane oxidation was determined from the difference in the ^{13}C amounts in both the CO_2 gas and microbial cells between

the $^{13}\text{CH}_4$ and $^{12}\text{CH}_4$ treatments measured using a Gas Isotope Mass Spectrometer. Methane oxidation anaerobically occurred with an extent of 0.3% of methane added. Although depletion of dissolved oxygen by action of facultative anaerobes after incubation for 3 hr did not further promote the oxidation, methane oxidation was suppressed mostly by addition of 0.5% oxygen, and completely by addition of 2.0% oxygen of headspace gas. Proportion of ^{13}C accumulated in the cells was about 9% of total ^{13}C oxidized. Methane oxidation was suppressed by both 2-bromoethanesulfonate and molybdate, which inhibited methane production and sulfate reduction, respectively, but was not suppressed by tungstate, which decreased nitrate reduction. These results suggest that methane oxidation occurs anaerobically in the rumen in consort with sulfate reduction, but its extent is not critical for reduction of methane production.

Key Words: Methane oxidation, Rumen, Oxygen

1220 Effect of enzyme feed additives and method of application on in vitro feed digestibility. D.P. Morgavi, R. Wuerfel, V.L. Nsereko, K.A. Beauchemin, and L.M. Rode, *Agriculture and Agri-Food Canada.*

Interest in the use of enzyme additives to improve feed digestion in ruminants is increasing. However, positive effects of this technology are not always reported in in vivo studies. Differences may originate in the production trait measured, type of enzyme(s), feed composition, and method of application. The aim of this work was to evaluate the effect of exogenous enzyme mixtures on in vitro feed dry matter (DM) and neutral detergent fiber (NDF) digestibility and determine whether method of enzyme application affects these parameters. Two commercially available enzyme mixtures were tested. Incubations were performed in revolving digestion incubators (Daisy II, ANKOM Technology, Fairport, NY) using the filter bag technique. Enzyme mixtures were applied by spraying an aqueous solution on the feed 24 h before incubation or by direct addition into the digestion vessel. Incubations were carried out for up to 48 h. When enzymes were applied in the liquid, the effects were inconsistent and in most cases, enzyme mixtures failed to increase digestion. In contrast, positive effects on DM and NDF disappearance were observed when enzymes were applied on the feed. However, the concentrations that elicited a response in vitro were higher than levels that are efficacious in vivo. Differences in digestibility due to enzyme mixtures were maintained up to 24 h of incubation ($P < 0.05$). DM and NDF contents of enzyme treated feeds measured before incubation were lower than controls. As much as 24.4% of NDF disappeared from corn silage treated with a high level of enzyme compared to 10% NDF disappearance for controls. One enzyme mixture was more effective in promoting digestion, but this effect could not be explained by the cellulase or xylanase activity present. Enzyme additives increased total in vitro DM and NDF disappearance when applied on the feed only, indicating that application method is an important factor in the successful adoption of this technology.

Key Words: Feed enzymes, Application method, Digestion

1221 Fermentation of feeds in lactating dairy cow diets by cultures and cocultures of amylolytic, proteolytic, and fibrolytic bacteria. G.A. Busher, A.H. Smith, M.R. Murphy, and E.J. Friedman*, *University of Illinois, Urbana.*

Interactions among an amylolytic (*Streptococcus bovis* JB1), a proteolytic (*Selenomonas ruminatum* lactilytica HD1), and a fibrolytic (*Fibrobacter succinogenes* AC3) species of ruminal bacteria in fermenting alfalfa hay, corn silage, a ground corn-soybean meal based concentrate mix, and a totally mixed diet were studied in vitro. The pH decreased 0.1 to 0.3 units in 24 h (from 6.8) for cultures and cocultures fermenting the alfalfa, corn silage, or totally mixed diet; however, it decreased 0.1 to 1.1 units in 24 h for for cultures and cocultures fermenting the concentrate mix, depending on the inoculum. The most rapid change in pH (modeled as a sigmoidal curve with an average $R^2 = 0.97$ and all parameters $P < 0.001$) occurred 3 h earlier in cultures fermenting the concentrate mix that were inoculated with both *S. bovis* and *F. succinogenes* than it did in cultures inoculated with *S. bovis* but not *F. succinogenes* (at 6.5 vs. 9.5 h, respectively). Dramatic and dynamic changes in end product concentrations also occurred when the concentrate mix was fermented. The apparent interaction between the

amylolytic and the fibrolytic species in fermenting the concentrate mix suggests that more research on this topic is needed.

Key Words: Fermentation, Dairy cow, Diet

1222 Effect of sample processing on *in situ* degradation of corn silage dry matter. R.G.S. Bruno, M.N. Pereira*, R.G. Von Pinho, and A.H. Fonseca, *Federal University of Lavras, Lavras, MG/Brazil.*

Unground macro *in situ* analysis of fermented silage has been proposed as the methodology to evaluate corn hybrids ruminal degradation. We wanted to know if we could extrapolate macro *in situ* data from data obtained with ground samples. Fifteen corn hybrids were cultivated in triplicate during the rainy season of 1998/1999 and ensiled at half milk line stage in mini-silos. Silage processing before rumen incubation differed within cultivar: dried for 48 hours at 58°C and ground through a 5 mm mesh, frozen ground through a 5 mm mesh, and undried and unground. Incubations were performed at once in 8 non-lactating cows fed sorghum silage *ad libitum* and 2 kg of corn-soybean meal concentrate. Five grams of dried and ground samples were inserted into 10x15 cm polyester bags and rumen incubated for 0, 12, 24, and 96 hours. Effective ruminal DM degradation (EFET) was calculated as the sum of the assumed instantaneously degradable DM fraction plus the slowly degradable DM times [kd/(kd+kp)], kp at 0.04/h. Disappearance of DM from the 24-hour bag was recorded (DEG24). Samples were frozen ground and fifteen grams incubated for 24 hours in 10x15 cm bags (FROZEN). Eighty grams of undried and unground samples were incubated for 24 hours in 25x30 cm macro bags (MACRO). For the 15 cultivars, the NDF as a % of silage DM was 51.8 ± 2.9 (mean ± DP), tons of DM per hectare 18.9 ± 1.3, EFET 56.3 ± 1.7, DEG24 61.1 ± 1.7, FROZEN 57.9 ± 5.0, and MACRO 51.2 ± 3.8. Correlation analysis on measures of ruminal digestibility was performed within cow-cultivar (N=120 per degradation procedure) (P<.001). Linear regression models to estimate MACRO were (as % of DM): -2.681 + 0.9556 EFET, 10.982 + 0.6579 DEG24, 30.172 + 0.3624 FROZEN. Extrapolation of macro *in situ* data from ground-sample data was not reliable.

Correlations	DEG24	FROZEN	MACRO
EFET	.93	.47	.45
DEG24		.32	.41
FROZEN			.37

Key Words: Corn silage, In situ, Macro bag

1223 Effect of a yeast/enzyme supplement on the performance of newly-arrived feeder steers. R. Dvorak*, *Alltech Inc., Nicholasville, KY.*

The objective of the study was to determine the effects of feeding a combination additive containing a live yeast culture (Yea-Sacc⁸⁴¹⁷), cellulases and extract from the Yucca plant (De-OdoraseTM) on the performance of newly-arrived feeder calves. Two hundred four crossbred steer calves averaging 250 kg were assigned to this trial. Animals were assigned to 20 pens based on weight and genetic background. Cattle were fed either the standard diet or the standard diet to which the combination additive (YCD) had been added at a rate to supply 15 g/hd/day. Treatments were assigned to pens in a randomized complete block design with ten replications (pens) per treatment. Calves received a full feed of long-stemmed grass hay upon arrival, which was gradually replaced with a complete, pelleted receiver feed over 7 days. The complete diets contained all natural protein and the assigned additive. No medications were used in the complete feeds. No death losses or serious health challenges occurred during the study. Dry matter intake (DMI) was significantly increased (P<0.05) by the YCD treatment during the first 13 days in the feedlot (5.56 vs 5.80 kg/day). For the entire 28 day trial period the YCD treatment resulted in a trend toward greater dry matter intake and average daily gain (ADG) (1.50 vs 1.56 kg/day ADG; 6.49 vs 6.60 kg/day intake). These results indicated a positive impact of the YCD supplement on dry matter intake and weight gain of feedlot cattle during the receiving period.

Key Words: Yeast culture, Yucca extract, feedlot

1224 Effects of Hydroxy Methyl Butanoic acid on *in vitro* and *in situ* degradability of forages. A. F. Mustafa*, D. A. Christensen, B. Sloan, and J. J. McKinnon, *University of Saskatchewan, Saskatoon, Canada.*

Two ruminally fistulated cows were used in a switchback design to determine the effects of Hydroxy Methyl Butanoic (HMB) acid on degradability of ruminant feeds. Cows were fed a 50:50 forage:concentrate diet and treatments were control (no HMB) and 20g/d of HMB. The effect of HMB on *in vitro* true DM digestibility was determined using samples of canola meal, alfalfa silage (AS), alfalfa hay (AH) and barley silage (BS). To determine the effects of HMB on ruminal disappearance of DM, CP, and NDF, samples of AH, AS, BS, and barley straw were incubated in the rumens of the two fistulated cows for 12, 24, and 48 h. Results of the *in vitro* study shows that feeding HMB improved (P < .05) *in vitro* true DM disappearance of AH, AS, and BS but not canola meal. Feeding HMB to cows increased (P < .05) ruminal disappearance of DM for barley straw and AS incubated in the rumen for 48 h. Similar effects were also observed for barley straw and barley silage samples incubated in the rumen for 24 h. It was concluded that feeding HMB at a level of 20 g/d could improve dry matter degradability of forage materials.

Key Words: Hydroxy methyl butanoic acid, Forage degradability

1225 Potential use of *Propionibacterium acidipropionici*, strain DH42, as a Direct-Fed Microbial for cattle. S.-W. Kim*, D.G. Standorf, H. Roman-Rosario, M.T. Yokoyama, and S.R. Rust, *Michigan State University, East Lansing.*

An experiment was conducted to evaluate the effects of *Propionibacterium acidipropionici*, strain DH42, on rumen fermentation of steers fed a high concentrate diet. Four, ruminally, cannulated steers (444 ± 6 kg) were used in a 4 X 4 factorial arrangement of treatments with 4 additives (Control, DH42, *Lactobacillus plantarum* (LAB), and DH42+LAB) and four sequential dose levels (10⁷, 10⁸, 10⁹, 10¹⁰ cfu/hd/d). Steers were adjusted to the experimental diets over a 14 day period and fed a diet consisting of 85% dry rolled corn, 10% corn silage and 5% protein-mineral supplement. The diet contained 11.5% crude protein and was fed once daily at 0830. Each treatment was soaked onto 1500 g of the diet as an admixture of the appropriate microorganisms in 200 ml of distilled water. Control received a sham treatment of 200 ml of distilled water. After the 1500 g of the diet had been consumed, steers were fed the remainder of the untreated diet to appetite. Each dose level was fed for 7 days, respectively. Ruminal samples were collected at 1, 4, 7, 10, 13, 16, 19 and 22 h after the daily dose of inoculants were consumed. With DH42, all dose levels had similar effect on acetate and propionate concentrations. The acetate/propionate ratio decreased with all treatments. Ruminal pH was not affected. Dietary inclusion of *Propionibacterium acidipropionici*, strain DH42, increased production of propionate at the expense of acetate at a minimal inclusion rate of 10⁷ cfu/hd/d.

	Control	DH42	LAB	DH42+LAB	SEM
	mol/100mol ^a				
Acetate	58.63 ^b	44.81 ^d	48.13 ^c	48.39 ^c	0.424
Propionate	21.45 ^e	42.98 ^b	40.21 ^c	32.53 ^d	0.628
Lactate	0.13	0.07	0.20	0.08	0.031
Acetate/ Propionate	2.80 ^b	1.05 ^d	1.22 ^d	1.57 ^c	0.048

^a Means of four treatment dose levels. ^{bcd} Means in the same row with unlike superscripts differ (p<.001).

Key Words: *P. acidipropionici*, DFM, Rumen fermentation

1226 Effect of soy hulls and Fibrozyme on intake, digestion, and milk production by dairy cows fed high corn silage diets. H. Al-Jobeile and R. Shaver*, *University of Wisconsin, Madison.*

Twenty-four multiparous Holstein cows (8 fitted with rumen cannulae) were used in a replicated 4 x 4 Latin square design with 35 d periods. Treatments were soy hulls- (SH) or corn-based (C) concentrates each fed with or without Fibrozyme (Alltech Inc., Nicholasville, KY). Diets were comprised of 33.5% corn silage, 16.5% alfalfa silage, and 50% of the respective treatment concentrate (DM basis). The grain and protein supplements included in concentrate C were dry ground shelled corn (47%),

44%-soybean meal (24%), and expeller soybean meal (20%). Concentrate SH was the same as concentrate C except that 50% of the corn was replaced with soy hulls. Sodium bicarbonate (1.5%) and magnesium oxide (.4%) were included in both concentrates. Diets formulated to contain 18% CP (DM basis) were fed as TMR once daily. Fibrozyme (0 or 15 g/cow/day) was added to the TMR in 57 g/cow/day placebo or Fibrozyme premixes. The corn silage averaged 40% DM and was harvested at a .95 cm TLC without crop processing. Dry matter intake and milk yield averaged 26.9 kg/d and 38.6 kg/d, respectively, and were unaffected by treatment. Milk fat percent and yield were higher ($P < 0.001$) for SH than C (3.27 vs 2.90% and 1.23 vs. 1.11 kg/d). Milk protein percent and yield were lower ($P < 0.001$ and 0.05, respectively) for SH than C (3.01 vs. 3.11% and 1.14 vs. 1.21 kg/d). Fibrozyme did not affect milk composition or component yields. Body weight change was unaffected by treatment. Fibrozyme increased ($P < 0.05$) rumen pH averaged across 0, 3, 6, 9, and 12-h post-feeding sampling times (6.22 vs. 6.14). Rumen pH was increased ($P < 0.05$) at 3 h (6.19 vs. 6.07) and 6 h (6.04 vs. 5.90) post-feeding by Fibrozyme. Rumen pH was higher ($P < 0.05$) for SH than C, but only at 3 h post-feeding (6.20 vs. 6.06). Ruminal 24-h DM disappearances from corn silage and alfalfa silage were unaffected by treatment.

Key Words: Soy Hulls, Milk Production, Digestion

1227 Microbial degradation of oligofructans may limit their potential as prebiotics for ruminants. Y. Wang*, T. A. McAllister, D. A. Gaudet, L. J. Yanke, and A. Laroche, *Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB.*

In response to rising public concern over the use of antibiotics in livestock production, and the impact of manure on the environment, researchers are investigating non-pharmaceutical agents that will promote or sustain high levels of productivity with minimal environmental impact. Oligofructans (OF) are polysaccharide derivatives produced by some plants as carbohydrate energy stores. Used as prebiotics for non-ruminants, OF have been shown to stimulate growth of *Bifidobacteria* and to reduce counts of *Bacteroides*, *Fusobacterium* and *Clostridium* spp. To investigate the potential of using OF to improve ruminant animal production, an in vitro incubation was conducted to assess ruminal degradability of a mid-sized OF isolated from winter wheat. Preliminary studies showed that *Bifidobacterium* spp. grew well on this OF. Stock solutions of the OF (and of corn starch, CS, for comparison) were added to ruminal fluid (20 mL) and substrate (300 mg) in serum vials to yield final OF or CS concentrations of 0, 500 or 1,000 $\mu\text{g/mL}$. Substrate was ground mixed ration comprising 60% barley silage, 35% barley grain and 5% supplement, and incubations were conducted anaerobically at 39°C. Triplicate vials were terminated at 0, 2, 6, 12 and 24 h to measure gas production, concentrations of OF and reducing sugars (RS), and in vitro DM disappearance (IVDMD). Oligofructans were not detectable in any vials beyond 0 h. Accordingly, RS concentrations were higher ($P < .05$) at 2 h in all OF and CS vials than in the controls. More gas was present in OF and CS vials at 6, 12 and 24 h than in controls ($P < .05$) and amount of gas increased with OF or CS concentration ($P < .05$), but treatment did not affect 24-h IVDMD ($P > .05$). Isolated OF were rapidly and completely degraded in ruminal fluid within 2 h. Thus, steps must be taken to protect these compounds against ruminal degradation before the positive effects observed with nonruminant animals may be extended to ruminants.

Key Words: Oligofructans, Ruminal degradation, Prebiotics

1228 Effects of exogenous fibrolytic enzymes on epiphytic microbial populations of barley and corn silages. Y. Wang*, T. A. McAllister¹, L. M. Rode¹, K. A. Beauchemin¹, D. P. Morgavi¹, V. L. Nsereko¹, A. D. Iwaasa², and W. Yang¹, ¹*Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB*, ²*Agriculture and Agri-Food Canada Research Centre, Swift Current, SK.*

The effects of applying exogenous enzymes to barley and corn silages on release of reducing sugars (RS) and on epiphytic microbial populations were examined in three 2 × 3 factorial experiments. The silages were treated either directly upon removal from the silos (BS, CS) or after having been autoclaved (ABS, ACS); in addition, CS removed from the silo (i.e., aerobically exposed) 24 h prior to processing was also studied (XCS, XACS). Treatments ($n = 3$) comprised applying 10 mL of water (control), a xylanase/ β -glucanase enzyme mix (E), or autoclaved enzymes (AE) per kg DM. After 24 h, RS concentrations were recorded,

and total bacteria (TB) and yeasts + moulds (YM) were enumerated. Autoclaving increased ($P < .05$) RS in both types of silage. Enzymes increased ($P < .05$) RS in fresh and autoclaved silages, more so ($P < .05$) with autoclaving than without. Treatment with AE did not affect RS. Microbial numbers were higher ($P < .05$) on XCS than on CS, and were below detectable limits on ABS, ACS, and XACS. Enzymes increased ($P < .05$) TB on both types of silage, more so on XCS+E than on CS+E. In a repeat study, ethylene oxide (EO) replaced autoclaving, and RS were measured 0 and 24 h after treatment. In both types of silage, RS were higher ($P < .05$) at 24 h than at 0 h, irrespective of EO. At 24 h, RS in enzyme-treated silages were higher ($P < .05$) with EO than without. Enzyme-associated increases in RS likely increased TB on the silages. Reducing epiphytic microbiota conserved enzyme-liberated RS in the silages. Aerobic exposure prior to applying enzymes enhanced RS-associated increases in microbial numbers. In releasing RS, exogenous enzymes may encourage silage deterioration if the interval between treatment and feeding is excessive. Enzymes effectively released RS from silages, but utilization of the RS by inherent epiphytic microorganisms may limit their availability to the ruminant.

Key Words: Feed enzymes, Silage, Reducing sugars

1229 Evaluation of folic acid supplementation in calf milk replacer on calf performance and health. M. A. Fowler*, B. L. Miller, T. E. Johnson, D. E. Housken, H. B. Perry, and M. R. Higgins, *Land O'Lakes, Inc., Webster City, IA.*

A calf performance trial was conducted with 41 Holstein bull calves (46.4 kg. average initial weight) to evaluate two levels of folic acid supplementation in an all milk protein calf milk replacer (CMR). Treatments consisted of two levels of folic acid supplementation – .5 ppm (NRC); 20 ppm. All calves received a medicated calf milk replacer (22% crude protein, 20% crude fat). Calves were allotted to treatment based on body weight and serum Ig status. Calves were fed CMR twice daily. Calves were weighed weekly with CMR consumption and subjective fecal scores recorded daily. All data are mean values for a 28-day period. Weight gain, CMR consumption and feed conversion for respective treatments were as follows – .5 ppm - 11.3 kg., 21.6 kg., 2.08 kg./kg. gain; 20 ppm - 12.1 kg., 21.2 kg., 1.90 kg./kg. gain. No differences in calf weight gain, CMR consumption, feed conversion, average fecal score and scour days were observed among treatments ($P > .05$).

Key Words: Folic acid, calf milk replacer

1230 The effect of Fermenten feeding on growth parameters in Holstein replacement heifers. B.N. Ellison¹, I.J. Lean*², M.A. Curtis³, and W.E. Julien¹, ¹*Biovance Technologies, Inc., Omaha, NE*, ²*Bovine Research Australia, Camden, NSW*, ³*Pictou, NSW.*

Six hundred and thirty eight Holstein heifers located on four different sites were used to evaluate the effects of Fermenten feeding on wither height, weight gain, and loin length *lastritocaudalpointofipsilateralpinbone*. Heifers at each site were either stratified on age or physical measurements, and randomly assigned to a Control or Treatment group. The Control diet was the existing ration at each site. The Treatment diet was formulated to give an isonitrogenous, isocaloric, isofibrous ration with respect to the Control diet. Fermenten was fed at the rate of 227 g for heifers weighing less than 182 kg, and 341 g for heifers weighing over 182 kg. All heifers were measured at day 0, 14, 35, 56, and 77 after trial initiation. A range of in growth responses was observed across trial locations, however, heifers fed the Treatment diet demonstrated a positive response in all measured growth parameters $P_{10.01}$ regardless of management system, stage of growth, diet ingredients, or season of year. After controlling for site, heifers fed the Treatment diet gained 20.76% more height at the withers $P_{10.01}$, 20.27% more length $P_{10.01}$, and 10.24% more weight $P_{10.01}$ than the control heifers. This series of studies demonstrated a nutritional intervention that can accelerate volumetric growth in Holstein dairy replacement heifers.

Key Words: Holstein heifers, Volumetric growth, Accelerated growth

1231 Effect of increasing level of dietary protein on growth and mammary development of Holstein heifers consuming a moderate-energy diet. R. Lopez*, C.R. Krehbiel, M.G. Thomas, B. Obeidat, D.M. Hallford, E. Castellanos, G. Bethard, R. Flores, and L. Balstad, *New Mexico State University, Las Cruces.*

Enhanced knowledge of the relationship between nutritional management of the heifer and lifetime milk production is important for maximizing dairy cow productivity. The dietary level of CP and the CP:ME dietary ratio could be used as a tool to manipulate physiological processes of growth and mammary gland development and increase lifetime milk production. Herein, twenty-four Holstein heifers (initial BW = 143 ± 30 kg) 120 d of age were individually fed a 52:48 concentrate:roughage diet (NEm = 1.61 Mcal/kg; NEg = 1.01 Mcal/kg) with increasing levels of protein (12, 14, 16, and 18% CP from soybean meal [SBM]; DIP = 68.5% of CP; n=6 heifers per protein level) or CP:ME ratio (75, 87, 100, or 112) until they reached puberty (291 ± 8.2 days). After puberty, heifers were slaughtered during the mid-luteal phase. Body weights were recorded at two-week intervals before and on the d of slaughter. At slaughter, viscera and organ weights were recorded. Body weights were greater ($P < .01$) across time in heifers consuming 16% CP relative to 12, 14, or 18% (263 ± 9 > 239 ± 7, 244 ± 7, 247 ± 7 kg) and a treatment x time interaction suggested that ADG was greater ($P < .01$) in heifers consuming 16% CP relative to heifers consuming 12, 14, or 18% for d 28-105 (1.2 ± .1 ≥ 1.0 ± .16, 1.06 ± .12, .96 ± .1 kg/d). Average daily DMI and gain:feed ratios were similar ($P = .18$) across these levels of protein consumption. Heifer BW on the d of slaughter was greater ($P = .02$) for heifers consuming 16% CP than in heifers consuming 18, 14, or 12% (412 ± 16 > 368 ± 14, 366 ± 13, and 335 ± 16 kg) as was hip-height (127 ± 3 > 119 ± 3, 119 ± 3, 114 ± 3 cm; $P < .03$), while BCS were similar ($P = .32$). No differences were observed ($P > .28$) in age at puberty or weights (g/kg BW) of viscera, liver, heart, spleen, lungs plus trachea, or mammary glands. Although maximum growth rate was achieved when heifers were fed 16% CP, these results suggest that levels of 12 to 18% CP from SBM can support a moderate to high growth rate in Holstein heifers without changes in viscera, liver, peripheral tissue, or mammary glands weights when moderate levels of energy are fed.

Key Words: Dairy Heifer, Protein, Growth

1232 Phytase addition to diets deficient in amino acids for grow-finish pigs. S. L. Johnston*, L. L. Southern, T. D. Bidner, and D. F. Coombs, *Louisiana State University Agricultural Center, Baton Rouge.*

One-hundred fifty gilts (initial weight = 20 kg) were used in a 106-d experiment to determine the effect on growth performance and carcass traits of phytase addition to diets deficient in amino acids, Ca, and P. The treatments were: 1) positive control (NRC adequate in amino acids, ME, Ca, and P), 2) a diet with 85% of the amino acids of Diet 1, but adequate in Ca and P, 3) a diet with 85% amino acids formulated with phytase expected to supply amino acids, ME, Ca, and P with added phytase, 4) Diet 3 but with no added phytase, 5) Diet 4 but adequate in Ca and P. The nutrient matrix values that were used for the phytase addition were: Ca 144%, aP 144%, ME 15,246 kcal/kg, Lys 12%, Met 5%, Thr 5%, and Trp 2%. The phytase was provided at 0.083% of the diet, and therefore was expected to provide the following nutrients: Ca 0.12%, aP 0.12%, ME 12.7 kcal/kg, Lys 0.01%, Met 0.004%, Thr 0.004%, and Trp 0.002%. Each treatment was replicated five times with six gilts each. Pigs fed diets with reduced amino acid concentrations (Diets 2 to 5) had lower daily gain ($P < 0.01$) than pigs fed the positive control diet adequate in amino acids and other nutrients (Diet 1). Pigs fed Diet 3 (added phytase) had gain:feed (G:F) equal to, or slightly greater, than pigs fed Diets 1 or 2, but they had greater G:F than pigs fed Diet 4 ($P < 0.05$) or Diet 5 ($P = 0.15$). Phytase addition to a diet with reduced levels of amino acids, Ca, aP, and ME had G:F slightly higher than pigs fed Diets 1 or 2. However, G:F was reduced in the diet without phytase and formulated to be deficient in amino acids, Ca, P, and ME (Diet 4). Feed efficiency was also lower in pigs fed the diet without added phytase but which had adequate Ca and P (Diet 5). In addition, pigs fed the diet containing phytase (Diet 3) had more muscle and fat than pigs fed the diet without phytase (Diet 2). In conclusion, phytase improved utilization of amino acids and ME, as well as Ca and P in diets for pigs.

Key Words: Pigs, Phytase, Amino Acids

1233 Effect of NDF from corn silage in diets of lactating dairy cows. D.M. Allen*¹, C.S. Kuehn¹, J.G. Linn¹, W.P. Hansen¹, H.G. Jung^{1,2}, and M.I. Endres³, ¹University of Minnesota, St. Paul, MN, ²USDA-ARS, St. Paul, MN, ³Mycogen Plant Sciences, Eagan, MN.

Two studies were conducted to evaluate the effect of NDF from corn silage on lactation performance. In year 1, fifty-one Holstein cows (22 primiparous (P) and 29 multiparous (M)) were assigned randomly to one of five dietary levels (18, 20, 22, 24, and 26% of total dietary DM), of forage NDF (NDF_F). Source of NDF_F was corn silage and alfalfa hay, with hay constant at 13% of the diet DM. As NDF_F increased, corn grain decreased and corn silage increased. Rumen inert fat was fed to maintain isocaloric diets. Cows received a standardized diet (22% NDF_F) from calving until 20 to 26 d post calving when dietary treatments were initiated and remained on their respective diets for 17 weeks. Dry matter intake of M cows was affected ($P < 0.05$) by diet with a decreasing DMI as NDF_F increased except at 26% NDF_F. Dietary treatment did not affect milk production, 3.5% FCM, BW, BCS, or DM digestibility within parity. Time spent chewing tended to increase linearly with increasing NDF_F in the diet. Year 2, seventy-four Holstein cows (21 P and 53 M) were assigned randomly to one of six dietary treatments. Three dietary levels of NDF_F, as contributed by corn silage and alfalfa hay (17, 20, and 22.5% of total dietary DM), with either an undegradable protein supplement (D; RUP 48.6% of CP; calculated) or a degradable protein supplement (U; RUP 32.5% of CP; calculated) were fed. Dietary NDF_F was varied as in year 1 except alfalfa hay was held constant at 10% of dietary DM. All cows were fed 20% NDF_F; D diet from calving until 20 to 26 d post-calving and then switched to their respective dietary treatment for 21 weeks. There was a numerical trend for decreasing DM intake as NDF_F increased for both protein supplements within parity. Milk yield was not different across treatments within parity. Various levels of NDF_F from corn silage can be fed as a total mixed ration when good feeding management practices are implemented without adverse health effects or compromising milk yield.

Key Words: corn silage, forage NDF, dairy cows

1234 Effects of brown midrib-3 mutation in corn silage on lactational performance of dairy cows. R. A. Longuski*, M. S. Allen, and R. J. Tempelman, *Michigan State University, East Lansing.*

Effects of brown midrib-3 (*bm3*) mutation in corn silage on lactational performance were evaluated using eighty Holstein cows (30 primiparous and 50 multiparous) in a full lactation experiment with a randomized complete block design. Corn hybrids (*bm3* or its isogenic normal equivalent) were grown in both 1997 and 1998 and ensiled for the study. In vitro NDF digestibility (30 h) was greater for *bm3* corn silage compared to control in both 1997 (57.0% vs 47.6%) and 1998 (62.1% vs 49.9%). Cows were offered diets containing a forage mix of 67% corn silage treatments and 33% alfalfa silage on a DM basis. Diets offered at calving were formulated to 30% NDF and 18% CP and cows were switched to diets with higher NDF and lower CP contents if body condition and daily milk production criteria were met past 84±3 DIM. Animals were housed in a freestall facility grouped by treatment and diet energy density, fed 1X/d and milked 3X/d. Body weight and body condition score were measured within 72 hours of calving, at 14±3 DIM, at 28±3 DIM and at 28 day intervals thereafter. Milk was sampled monthly (3X/d) for each cow and analyzed for CP and fat content. Data from ten test days at 30-d intervals were analyzed using mixed effects models including effects of hybrid, DIM or stage of lactation, parity, silage year and diet energy density. A significant treatment by stage of lactation interaction ($P=0.05$) was observed for solids corrected milk (SCM) yield. Yield of SCM was numerically lower for *bm3* treatment at test month 1 but higher for test months 2 (2.4 kg/d, $P=0.07$), 3 (3.5 kg/d, $P=0.01$) and 5 (2.6 kg/d, $P=0.05$) compared to control treatment. Cumulative SCM from 50 to 150 DIM was greater for *bm3* treatment compared to control (3282 vs. 2990 kg, $P<0.01$). Milk CP content was greater for *bm3* treatment than control (3.02 vs 2.87%; $P<0.01$). No differences were observed between treatments for milk fat content, body weight, or body condition score. These results suggest that milk yield response for dairy cows fed *bm3* corn silage compared to control is greatest at peak lactation.

Key Words: Corn silage, Brown midrib, Full lactation

1235 Effect of hybrid, maturity, and mechanical processing of corn silage on intake and digestibility by beef cattle. J. G. Andrae^{*1}, C. W. Hunt¹, L. R. Kennington¹, G. T. Pritchard¹, W. Kezar², and W. Mahanna², ¹University of Idaho, Moscow, ²Pioneer HiBred International, Johnston, IA.

A study involving a 2 x 2 x 2 factorial arrangement of treatments was conducted to evaluate the effects of hybrid (Pioneer 3335 and 3489), maturity (half milkline and blacklayer), and mechanical processing (field chopper with and without on-board rollers engaged) on intake and digestibility of corn silage. Forty beef steers (322 kg BW) were stratified by weight groups, randomly assigned to silage treatments, and individually fed using electronic feeding gates. Diets consisted of 60 percent corn silage and 40 percent alfalfa hay (DM basis). Following a 5-d adaptation period, intake was measured for 7 d and fecal samples were collected for 5 d. Chromic oxide (5 g/d) was fed beginning 7 d prior to fecal collection and digestibility was determined by the ratio of Cr in the feed and feces. Steers were reallocated and these procedures were repeated providing 10 observations per treatment. At full maturity 3489 produced drier silage that phenotypically had coarser stover and harder cob fragments than 3335. Processing increased DMI of 3489 but did not affect DMI of 3335 (hybrid x processing; P < .06). Total tract digestibility of DM, starch, NDF, and ADF decreased (P < .01) as plant maturity increased. Maturity decreased starch digestibility more for 3489 than 3335 (hybrid x maturity; P < .10). Processing increased (P < .01) starch digestibility, but decreased (P < .01) NDF and ADF digestibility resulting in no processing effect for DM digestibility. Processing numerically increased starch digestibility more for late than early maturity corn silage (maturity x processing; P = .11). These data indicate that hybrid, maturity, and processing all affect corn silage digestibility. Mechanical processing of corn silage increased starch digestibility which may have disrupted ruminal fermentation resulting in decreased fiber digestibility.

Key Words: Corn Silage, Maturity, Processing

1236 Influence of the particle size of barley silage on the effective fiber characteristics. H.W. Soita^{*}, D.A. Christensen, and J.J. McKinnon, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

The aim of this study was to examine the influence of forage particle size on the effective fiber characteristics. Six steers (435 kg) equipped with ruminal cannulas were used in a 2 x 2 Latin square design to test two theoretical length of cut of barley silage (short SS = 4.85 mm and long LS = 18.0 mm). The diets were straight silage with a salt and trace mineral supplement. Dry matter intake was higher (P < .05) for the steers fed SS diets. Feeding LS diets sharply reduced DM and cell wall constituents digestibilities (P < .05). Feeding SS diets reduced mean rumen pH, ammonia, acetate: propionate ratio, molar proportion of acetic acid and increased the molar proportions of propionic acid and total VFA. The range of pH during the day and the time when pH and ammonia concentration were low (< 6.2 and 5.0 mg/dL, respectively) were increased. Eating rate average 38.3 g/min, however saliva production was higher (P < .05) for LS diets. Ingestive mastication reduced (P < .05) feed particle size retained on the first and second screen (>18 mm) of the LS as compared with SS. Rumen mean retention time was higher for LS as compared with SS. It is concluded that reduced barley silage particle size can influence the quantity and nature of digestive end products by altering chemical and physical conditions in the rumen.

Key Words: Barley Silage, Particle Size, Metabolic responses

1237 Effects of feeding pea silage on milk yield and composition of dairy cows. A. F. Mustafa^{*}, D. A. Christensen, and J. J. McKinnon, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Six Holstein cows in early lactation were used in a double 3 x 3 Latin square design to determine the effects of feeding pea silage (PS) as forage source relative to barley (BS) and alfalfa (AS) silage. Cows were fed rations formulated to contain 50:50 forage to concentrate ratio. Two Ruminally fistulated cows were used in a randomized complete block design to determine ruminal nutrient degradability for PS relative to BS and AS. Pea silage contained a lower (P < .05) NDF, ADF and starch but a higher (P < .05) CP level than BS. When compared with AS, PS had a higher (P < .05) starch and NDF but a lower (P < .05) CP content. Rate of degradation and effective ruminal degradability of NDF

was highest for AS, intermediate for PS and lowest for BS (P < .05). Dry matter intake and milk yield were not affected by forage source. However, cows fed PS or AS tended to produce more milk (2 kg/d) than cows fed BS. Milk composition was similar for cows fed PS or BS. However, Cows fed PS produced milk with a higher (P < .05) fat and a lower (P < .05) protein percentage than cows fed AS. It was concluded that PS can replace BS and AS as a forage source for dairy cows in early lactation.

Key Words: Pea silage, Milk yield and composition, Dairy cows

1238 Comparative timed intakes of grain supplements for lactating Jerseys and Holsteins on pasture. S.L. White^{*1}, S.P. Washburn¹, C. Arellano¹, and J.T. Green, Jr.¹, ¹North Carolina State University, Raleigh.

This experiment compared intakes of grain supplement between Jerseys (J; n=9) and Holsteins (H; n=9) managed on pasture. Cows calved in September and were offered supplement twice a day before each milking. Supplement consisted primarily of ground corn, whole cottonseed, and soybean meal (42, 27, and 15 % of DM, respectively). Intake measurements were taken for six consecutive days in January (Period 1), March (Period 2), and May (Period 3). Amounts offered each cow at each feeding were 6.83 kg, 4.55 kg, and 2.27 kg for Periods 1, 2, and 3, respectively. Supplements were reduced in spring because of greater availability of pasture. The experiment was a Latin square with two squares within each period. During the first 3 days (square 1) intakes were measured at 2.5, 7.5, and 12.5 min and during the next 3 days (square 2) intakes were measured at 5, 10, and 15 min. Sets of 3 cows of each breed were assigned within each square such that each cow was allowed access to the grain supplement for each of the six time intervals over each 6-day period. Cows were fed individually before the afternoon milking and intakes determined by measuring orts at appropriate time intervals. The General Linear Models procedure in SAS was used for statistical analyses within period. Cow within breed was used as the error term for testing breed effects. Amounts of feed eaten increased with time but did not differ significantly between the two breeds. Numerically, Holsteins averaged eating at least 0.3 kg more supplement several times, particularly during January when more feed was offered and less pasture was available.

	Period 1 (6.83 kg offered)		Period 2 (4.55 kg offered)		Period 3 (2.27 kg offered)	
Eating Time (minutes)	H	J	H	J	H	J
2.5	1.07	0.96	0.81	0.81	1.02	1.01
5	2.22	1.88	1.73	1.61	1.89	1.74
7.5	2.97	2.50	2.29	2.15	2.13	2.04
10	4.15	3.66	2.79	3.02	2.23	2.26
12.5	4.49	3.97	3.28	3.05	2.24	2.27
15	5.39	5.02	3.78	3.48	2.23	2.27
S. E.	± .13		kg eaten ± .18		kg eaten ± .04	

Key Words: Breeds, Pasture, Intake

1239 Short periods of sub-optimal pH reduce digestibility of pasture in vitro. M.J. de Veth^{*} and E.S. Kolver, Dairying Research Corporation Ltd, Hamilton, New Zealand.

Four dual flow continuous culture fermenters were used in a 4x4 Latin square design to establish the effect of diurnal variation in ruminal pH on pasture digestion and microbial protein synthesis. Fermentation of high quality pasture (22% CP, 43% NDF) was controlled at pH 5.4 (sub-optimal) for four different intervals of each day (0, 4, 8, 12 h). During the remainder of each day pH was controlled at 6.3 (optimal). Automatic infusion of 5 N NaOH and 5 N HCl controlled pH to ±0.05. Samples were collected during the last 3d of each of the four 9-d experimental periods. Increasing the period of time at sub-optimal pH from 0 to 12 h/d reduced OM and DM digestibility by 8 percentage units, NDF digestibility by 15 percentage units and microbial N flow by 23%, but had no effect on total non-structural carbohydrate (TNC) digestion or efficiency of microbial protein synthesis. A negative linear relationship was observed between time at sub-optimal pH and digestibility of OM, DM, NDF, and microbial N flow. Digestibility of OM, DM, and NDF was reduced after exposure to sub-optimal pH for 4 h, but microbial

N flow was only significantly reduced after 8 h. These results indicate that short periods of sub-optimal pH inhibited the activity of the rumen microbial population, but longer periods of sub-optimal pH (>8 h) were required before ruminal flow of microbial N was significantly impaired. This experiment confirmed that the microbial population was able to adapt to a ruminal pH below 6.0 and exhibit high levels of digestion when an all-pasture diet was fed.

	Time at sub-optimal pH (hours)				SED	P ¹
	0	4	8	12		
True ruminal digestibility (%)						
OM	65.9 ^a	61.8 ^b	59.4 ^{bc}	58.2 ^c	1.03	0.001
DM	65.5 ^a	61.2 ^b	59.0 ^{bc}	57.6 ^c	1.05	0.001
Apparent ruminal digestibility (%)						
TNC	66.8	63.5	61.9	60.0	2.32	0.025
NDF	76.0 ^a	72.0 ^b	68.7 ^c	67.4 ^c	1.08	0.001
Microbial N flow (g N/d)	0.39 ^a	0.37 ^a	0.34 ^a	0.30 ^b	0.02	0.002
Efficiency of microbial protein synthesis (g N/kg OM digested)	10.9	11.1	10.8	9.4	0.52	0.029

¹ Linear relationship between pH treatments; ^{a,b,c}Means in a row with a different subscript differ (P<0.05)

Key Words: Pasture, pH, Rumen

1240 Digestibility of diets containing whole linted cottonseed as a forage substitute when fed with ground or steam-flaked corn. D.I. Harvatine* and J.L. Firkins, *The Ohio State University, Columbus.*

Six mid-lactation primiparous Holstein cows (517 kg), fitted with ruminal and duodenal cannulas, were used in a 6 x 6 Latin Square with 3-wk periods. The objective was to quantify the site and extent of digestion when NDF from whole linted cottonseed (WCS) replaced alfalfa silage NDF and corn varied in ruminal starch availability (ground (G) or steam-flaked (SF)). Treatments were: forage control with G [FCG] (21% forage NDF (fNDF)); low (5%) WCS with G [LG] or SF [LSF] (18% fNDF); medium (10%) WCS with G [MG] or SF [MSF] (15% fNDF); and high (15%) WCS with G [HG] (12% fNDF). Diets had similar total NDF, CP and fat. DMI increased quadratically (P<0.05) with increasing substitution of fNDF with NDF from WCS (17.8, 20.0, 20.5, 20.3 kg DM for FCG, LG, MG, and HG). DMI decreased for cows fed SF (P<0.05) compared to G (19.2 and 18.2 kg for LSF and MSF vs. 20.0 and 20.5 kg for LG and MG). No difference was detected in ruminal NDF digestibility (39.4, 38.8, 37.5, 38.8% for FCG, LG, MG and HG), although there was a linear decrease (P<0.01) in total tract NDF digestibility (58.5, 55.3, 54.8, 48.3% for FCG, LG, MG and HG) with increasing level of WCS substitution. No effect of corn source was detected for NDF digestibility. NSC intake increased linearly (P<0.01) with increasing level of WCS inclusion (4.0, 5.0, 5.1, 5.7 kg for FCG, LG, MG, and HG). Apparent ruminal NSC digestibility increased linearly (P<0.05) (49.5, 55.3, 54.1, 66.4% for FCG, LG, MG and HG), although there was no difference in total tract NSC digestibility (95.1, 96.7, 97.0, 96.5% for FCG, LG, MG and HG) with increasing WCS substitution. SF increased (P<0.01) apparent ruminal NSC digestibility (75.8 and 79.4% for LSF and MSF vs. 55.3 and 54.1% for LG and MG) and increased (P<0.01) total tract NSC digestibility (99.4 and 99.8% for LSF and MSF vs. 96.7 and 97.0% for LG and MG) as compared to G. No interactions of corn source and WCS level were detected for NDF and NSC digestibility.

Key Words: Corn processing, Whole Cottonseed, Digestion

1241 Effects of cottonseed hulls in the diets of dairy cows. A. M. Akinyode*¹, M. B. Hall¹, C. R. Staples¹, H. H. Head¹, and W. E. Kunkle², ¹Dept. of Dairy & Poultry Sciences, ²Dept. of Animal Science, University of Florida, Gainesville.

Our study evaluated the effect of providing a portion of dietary roughage as cottonseed hulls (CSH). Ten Holstein cows in mid-lactation, of which five were ruminally cannulated, were randomly assigned to dietary treatments in a 4x4 Latin square design. The isonitrogenous total mixed ration contained 40% roughage (sorghum silage and/or CSH) and 60% concentrate (corn meal, soybean meal, whole cottonseed, distillers grains, citrus pulp and minerals). Cows were fed individually twice daily. Treatment diets contained 0, 8, 16 and 24 percent of diet dry matter (DM) as CSH replacing sorghum silage. The experimental periods were 21d long with the last 7d for sampling. Cr-mordanted NDF (30g) was pulse-dosed orally or intraruminally on day 15 and fecal samples (n=28) were collected over an 82 h period for calculation of rate of passage (kp). Fecal pH was measured. Ruminal pH was measured for 12 h on d 21. Values reported are least squares means. Significance was declared at P<0.05. Dry matter intake (DMI), intake of concentrate DM, and DMI as a percentage of body weight (DM%BW) differed among treatments. DMI increased linearly with increasing CSH. Fecal pH decreased with increasing CSH, suggesting increased fermentation in the large intestine. Total tract kp, daily milk production, feed efficiency and ruminal pH did not differ among treatments. In conclusion, increasing dietary concentration of CSH increased DMI and maintained ruminal pH, although estimated kp was not affected. However, the reduction in fecal pH implies a partial shifting of nutrient digestion to the lower gut.

CSH % of diet DM	0	8	16	24	SEM
DMI, kg/d	20.7	22.9	24.3	25.3	0.81
DMI%BW	3.00	3.50	3.70	3.90	0.002
Ruminal pH	6.20	6.20	6.20	6.17	0.52
Fecal pH	6.50	6.43	6.44	6.36	0.04
Kp, h ⁻¹	0.051	0.054	0.056	0.053	0.002
Milk, kg/d	20.7	19.5	20.7	20.7	2.42
Milk/DMI, kg/kg	0.86	0.87	0.84	0.81	0.08

Key Words: Dairy Cattle, Cottonseed Hulls, By-product Feeds

1242 Altering diurnal pH and *in situ* digestion in dairy cows with ruminal supplementation of direct fed microbials (DFM) and yeast. J.E. Nocek*¹, W.P. Kautz², J.A.Z. Leedle², and J.G. Allman², ¹Spruce Haven Farm and Research Ctr, ²Chr. Hansen BioSystems.

Three ruminally-cannulated cows(70 DIM)were used to evaluate the effects of DFM and yeast supplementation on diurnal rumen pH profiles and *in situ* digestibility. Treatments were: a)control, b)DFM(*Enterococcus faecium*and *Lactobacillus plantarum* at 1x10⁵), c)10g Biomate Yeast-Plus, and d) combination of b and c. All treatments were directly incorporated into the rumen via fistula once daily. Cows were fitted with indwelling rumen pH probes connected to data-loggers. Rumen pH values were summarized hourly. The experimental period was 21d: 7d adjustment, 4d *in situ*, 10d pH monitoring. *In situ* digestion rates were conducted on high moisture ear corn(HMEC), haylage and corn silage (CS). Cows fed DFM had higher mean daily lowest(MDL) pH values compared to other treatments. Cows fed yeast or DFM/yeast tended to have higher rumen pH values. Area under the curve(AUC) for pH <5.5 was lowest for cows receiving DFM compared to other treatments. Rate of haylage DM digestion was highest for cows receiving DFM. Rate of HMEC and CS DM digestion tended to be higher for cows receiving DFM/Yeast. These data demonstrate that addition of a specific DFM aids in reducing ruminal acidity and affects DM digestion rates of some forages.

Parameter	Control	DFM	Yeast	DFM/Yeast	SEM
MDL pH	5.33 ^b	5.58 ^a	5.43 ^b	5.44 ^b	.04
AUC, <5.5	54.1 ^a	41.3 ^b	57.1 ^a	63.3 ^a	3.2
KdB, %/h					
HMEC	4.65	5.27	4.85	5.55	.53
Haylage	5.41 ^b	7.13 ^a	4.94 ^b	4.81 ^b	1.05
CS	4.33	4.98	3.58	4.75	.71

^{a,b}means in the same row are different, P<.05

Key Words: DFM, rumen, pH

1243 The effect of various combinations of fibrolytic enzymes on the feeding value of a TMR fed to lactating cows. L. Kung, Jr.¹, J. A. Lazartic*¹, R. L. Wuelfel², L. M. Rode², K. A. Beauchemin², and R. J. Treacher³, ¹University of Delaware, Newark, ²Agriculture and Agri-Food Canada, Lethbridge, ³Finnfeeds Intl., Marlborough, UK.

We tested the effect of feeding cows TMR that had their forage component treated with fibrolytic enzymes prior to feeding. Twenty seven multiparous and 3 primiparous Holstein cows averaging 93 DIM and 38 kg of milk/d were fed a TMR of 30% corn silage, 15% alfalfa hay, and 55% concentrate (DM basis). After a 14-d pretreatment period, cows were blocked on parity and milk yield before being randomly allocated to one of the three treatments. During a 12-wk treatment period the forage portion of the TMR was treated with: 1) no enzymes, 2) cellulase complex D and hemicellulase complex B (3400 CMCase units and 10,450 xylanase units/kg forage DM), or 3) cellulase complex D and hemicellulase complex C (3350 CMCase units and 10,500 xylanase units/kg forage DM). Enzymes were diluted in water and applied to forages with in 30 min (10 l/1000 kg fresh forage) before mixing into the TMR. A similar amount of water was added to untreated forage in treatment 1. Diets were fed to cows within 30 to 60 min of enzyme treatment. Dry matter intake (kg), milk production (kg), milk fat (%) and milk protein (%) for treatments 1, 2, and 3 were not affected by treatment and were: 26.9, 27.8, 27.2; 37.2, 39.0, 36.8; 3.33, 3.44, 3.29; and 3.10, 3.14, 3.09, respectively. However, cows fed treatment 2 produced 2.5 kg ($P < 0.12$) and 2.8 kg ($P < 0.08$) more 3.5% FCM than cows fed treatment 1 and 3, respectively. In vitro gas production of the treated forage portions of the diets was greater ($P < 0.05$) from enzyme treated forages than from untreated forage, but 96 h VFA production was not different among treatments. Enzyme activity at pH above 6.0 was similar for both hemicellulase enzymes. However, activity was greater at lower pH for hemicellulase complex B. These data show that in vitro gas production does not accurately predict in vivo response to various fibrolytic enzymes. The apparent discrepancy may be related to differences in enzyme activity at low pH.

Key Words: Enzymes, Lactation, Forage

1244 Effects of Tween 60 and Tween 80 on protease activity, thiol group reactivity, protein adsorption and cellulose degradation by rumen microbial enzymes. G. M. Kamande¹, J. Baah*², K.-J. Cheng³, T. A. McAllister², and J. A. Shelford³, ¹PMT Inc. (Prairie Microtech), Regina, SK, ²Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ³University of British Columbia, Vancouver, BC.

Microbial enzymes extracted from mixed ruminal microorganisms were incubated for 2 h with casein and Tween 60 or Tween 80 at 10 concentrations ranging from 0 to 2.0% (vol/vol) to determine the effects of these nonionic surfactants on protease activation and thiol reactivity (unmasking of thiol groups). Rate and extent of protein adsorption to cellulosic substrate (barley straw) was measured in the presence of 0, .05, .10, .25, and .50% (vol/vol) Tween 80. Degradation of cellulose by a rumen bacterial fraction was measured over 48 h of incubation with and without Tween 60 or Tween 80 at .25% (vol/vol). Maximum accelerations of protease activity achievable with Tween 60 and Tween 80 (calculated from a Michaelis-Menten kinetics model) were 99.2 and 166.8%, respectively. Concentrations of Tween 60 and Tween 80 at which half the maximal velocities were attained were .28 and .20% (vol/vol), respectively. Tween 80 increased ($P < .05$) the rate and extent of adsorption of microbial protein to barley straw, and the effect was related to concentration of Tween 80 up to .10% (vol/vol). Initial rates of cellulose degradation with no surfactant, .25% Tween 60, or .25% Tween 80 were .60, .87, and 1.04 $\mu\text{g}/\text{mL}$ per h, respectively. These nonionic surfactants were effective for enhancing rumen microbial protease and cellulase activities. Thus, further study is warranted to determine their potential for improving ruminant feeding.

Key Words: Ruminal proteases, Surfactants, Cellulose degradation

1245 Protein value of wet brewers grain for dairy cattle. A. M. van Vuuren*¹, A. Klop¹, G.A.L. Meijer¹, J. Kogut¹, and E. de Koning², ¹ID-Lelystad, ²Bonda's Veevoederbureau, Hillegom, The Netherlands.

Fluxes of amino acids in the portal vein suggested that the protein value of wet brewers grain (WBG) is higher than predicted from in situ incubations (van Vuuren et al., 1998, J. Dairy Sci. 81, Suppl. 1: 343). Therefore, we compared the duodenal N fluxes in dairy cows, provided with a ruminal cannula and a duodenal cannula, fed total mixed diets containing either WBG or solvent soybean meal. In a Latin square designed experiment (4 cows x 4 periods), 3 diets were tested: 1) a control diet containing grass silage, corn silage, and a concentrate mixture (26, 40 and 33 % of total DM, respectively); 2) a WBG diet in which 3.5 kg of DM of the control diet was replaced by 4.4 kg of ensiled WBG (DM: 25.3%; CP: 24.2% of DM); 3) a SOY diet in which 3.5 kg of DM of the control diet was replaced by 1.4 kg of solvent soybean meal (CP: 47.4% of DM) and 1.9 kg of soybean hulls. Duodenal fluxes were calculated using Cr-NDF and Co-EDTA as markers. The highest duodenal fluxes of AA N were observed for the WBG diet (Table). The duodenal AA N flux was approximately 60 g higher than for the control and SOY diets. Microbial N fluxes were not different between treatments. For WBG, the calculated value for available protein at the duodenum (DVE; Tamminga et al., 1994, Livest. Prod. Sci. 40:139-155) in vivo was 177 g DVE/kg of DM, whereas the calculated value from in situ results was 92 g DVE/kg of DM. The difference between both estimates could be due to a low rate of rumen degradation of the washout fraction. These observations agree with the portal AA fluxes (van Vuuren, 1998).

Parameter	Diet			SE of difference	P level
	Control	WBG	SOY		
Intake					
OM, kg/d	16.8	18.0	16.9	0.4	0.053
N, g/d	475	561	538	13	0.001
Duodenal flux					
AA N, g/d	330	392	334	16	0.008
Micr. N, g/d	365	358	333	24	0.410
DVE ¹ in vivo, g/kg DM	89	177 ²	100 ²		
DVE in situ, g/kg DM	84	92	160		

¹DVE: available protein at duodenum; ²DVE value for supplemental WBG and solvent soybean meal.

Key Words: Wet brewers grain, Protein, Dairy Cattle

1246 Effect of increasing ruminally degraded protein on ruminal and total tract digestion of nutrients in dairy cows. K. F. Kalscheur*^{1,2}, B. P. Glenn², R. L. Baldwin VI², and R. A. Kohn¹, ¹University of Maryland, College Park, ²USDA, Agricultural Research Service, Beltsville, MD.

The objective of this experiment was to determine the effects of increasing ruminally degraded protein (RDP) on nitrogen metabolism and nutrient digestion in lactating dairy cows. Three ruminally and duodenally cannulated multiparous Holstein cows were assigned one of four diets in a 3 x 4 incomplete Latin square design with 3-wk periods. Diets were formulated to provide four concentrations of RDP (% of DM) while rumen undegraded protein remained constant: 1) 7.3% RDP; 2) 8.8% RDP; 3) 10.3% RDP; and 4) 11.7% RDP. Diets contained 50% corn silage and 50% concentrate (DM basis). Ingredients of the diets were equal across treatments except for the change in ground corn, soybean meal and protected soybean meal (Soypass[®]). DMI increased as dietary RDP increased (18.2 to 19.4 kg/d; $P < 0.04$). Milk yield tended to increase linearly with increasing RDP in the diet (22.3 to 25.9 kg/d; $P < 0.07$). 3.5% FCM (20.7 to 24.4 kg/d; $P < 0.02$), fat yield (0.68 to 0.81 kg/d; $P < 0.03$), protein yield (0.63 to 0.75 kg/d; $P < 0.04$), and milk urea nitrogen (6.8 to 13.3 mg/dl; $P < 0.007$) increased linearly with increasing RDP in the diet. Total N flow to the small intestine increased ($P < 0.03$), nonbacterial N tended to increase ($P < 0.10$), and urinary N increased ($P < 0.003$) linearly as cows were fed an increasing amount of RDP. Bacterial N flow to the duodenum and microbial synthesis were unaffected by treatment. Although bacterial protein synthesis appeared unaffected by treatment, increases in RDP resulted in higher N flow to the small intestine and increased milk yield, fat yield, and protein yield.

	Treatment				SEM	P ¹
	1	2	3	4		
N intake, g/d	383.0	449.6	486.1	553.1	38.4	0.001
Duodenal flow, g/d						
Total N	376.6	417.4	437.8	487.5	65.4	0.03
Nonbacterial N	220.0	255.2	257.0	315.2	45.4	0.10
Bacterial N	156.7	162.2	180.8	172.2	27.8	NS
Bacterial synthesis						
g of N/kg of OMTD	15.7	15.3	17.5	16.7	1.9	NS
Urinary N, g/d	99.2	138.6	167.5	217.2	21.0	0.003
Fecal N, g/d	163.2	164.7	172.1	169.3	23.8	NS
N digestibility, %	57.9	63.0	64.4	69.0	2.1	0.009

¹Linear effect.

Key Words: Ruminally degraded protein, ruminal nitrogen metabolism

1247 Influence of ruminally degradable carbohydrates and nitrogen on microbial crude protein supply and N efficiency of lactating Holstein cows. R.A. Sannes*¹, D.B. Vagnoni², and M.A. Messman², ¹Utah State University, Logan, ²Cargill Animal Nutrition Center, Elk River, MN.

Sixteen multiparous lactating Holstein cows (4 with rumen cannulae) were fed diets varying in the content of ruminally degradable carbohydrates and N to examine dietary effects on microbial CP flow, whole animal N efficiency, and to evaluate the model of Jonker et al. (J. Dairy Sci. 81:2681) for predicting urinary N excretion and N efficiency from milk urea N concentrations. A replicated Latin square design (consisting of diet and experimental period) was employed. The four diets consisted of a low protein diet with 20% ground corn (LP corn), LP with 3% sucrose (LP sucrose), a high protein diet containing 3% sucrose and 0.8% urea (HP urea), and a high protein diet containing 3% sucrose and 5.4% soybean meal (HP SBM). Dietary means were separated using 3 single df contrasts to evaluate carbohydrate source (LP corn vs LP sucrose), CP level (LP sucrose vs HP urea and HP SBM) and CP source (HP urea vs HP SBM). The intakes of DM and N were increased (P < .05) by increasing dietary CP level. However, the yields of milk and milk protein were not affected (P > .2) by CP level. Microbial CP flow was reduced (P = .03) by sucrose and was increased (P = .03) by CP level. There was no effect (P > .18) of CP source on DM intake, milk yield, or microbial CP flow. Urinary N excretion (mean = 252 g/d) was underestimated (P < .01) by 55 g/d using the equations of Jonker et al. and was overestimated (P = .02) by 25 g/d using a modified equation of Kauffman and St-Pierre (J. Dairy Sci. 82 (Suppl. 1): 95). Nitrogen efficiency (mean = 22.4%) was underestimated (P < .01) by 7.5% and 3.2% using the equations of Jonker et al. and Kauffman and St-Pierre, respectively. The magnitude of the error of these predictions using the latter equations (10% and 14% for urinary N excretion and N efficiency, respectively) suggest that milk urea N is a useful tool for evaluating N losses and N efficiency in lactating Holsteins.

Key Words: Dairy Cattle, Milk Urea Nitrogen, Dietary Carbohydrate

1248 Effect of each amino acid on growth efficiency of ruminal bacteria. H. Kajikawa*¹, ¹National Institute of Animal Industry, Tsukuba, Japan.

Estimation of microbial synthesis in the rumen is a crucial factor for the absorbed protein system. Ruminal bacteria can grow with NPN as sole N source, but their growth efficiency is known to be improved in the presence of amino acids. This study was done to investigate effect of each amino acid on the growth rate and efficiency of mixed ruminal bacteria since the effect has not been well clarified yet. Ruminal bacteria were harvested from the mixture of solid and fluid portions taken from a ruminally fistulated Holstein cow having timothy hay at maintenance level. Protozoa were removed by centrifugation. After washed once with Na-K phosphate buffer, the bacterial cells were anaerobically and isonitrogenously (100 mgN/L) incubated with glucose, xylose and cellobiose (4, 4 and 2 mM, respectively). Amino acid-N was replaced with 25% (=25 mgN/L) of nitrogen in the control treatment which had ammonium-N as sole N source. Growth efficiency was estimated from ratio of cell protein increased to amount of sugars consumed at exponentially growing stage. Sugars were analyzed by a capillary electrophoresis. Growth rate and efficiency were significantly improved in the presence of twenty amino acids in equal amounts, but no specific sole amino acid improved them. When whole amino acids lacking only one amino acid were added, the

improvement of growth rate and efficiency was suppressed in the absence of tryptophane, tyrosine, glutamate or methionine. Isoleucine had an inhibitory effect on bacterial growth rate and efficiency. Growth rate and efficiency were highly correlated with each other, which suggesting that ratio of energy consumed for maintenance and growth would be the decisive factor for the efficiency.

Key Words: Rumen bacteria, Growth efficiency, Amino acid

1249 Effect of feeding protein supplements with differing ruminal degradabilities on milk production and rumen metabolites in dairy cows. S. M. Reynal*¹, G. A. Broderick², and S. Ahvenjarvi³, ¹University of Wisconsin, Madison, ²U.S. Dairy Forage Research Center, Madison, WI, ³Agricultural Research Center of Finland, Jokioinen.

Nineteen multiparous and 6 primiparous (ten ruminally fistulated) Holstein cows in early-mid lactation (82 ± 34 DIM) were assigned to 5x5 Latin squares (21-d periods) and fed diets with different protein supplements to determine the effect of ruminal protein degradation on milk production and composition and on rumen variables. Total mixed rations were (DM basis): 43.5% corn silage, 22% alfalfa silage, 2% urea, and 31% concentrate (protein supplement plus rolled high moisture shelled corn, RHMSC). Diets were: Control (31% RHMSC); SSBM (22% RHMSC, 9% solvent soybean meal); ESBM [21% RHMSC, 10% expeller soybean meal (Soy Plus[®])], BM (25.5% RHMSC, 5.5% blood meal); and CGM (24% RHMSC, 7% corn gluten meal). Crude protein content of the diets was, respectively, 15.7, 19.1, 19.7, 20.3 and 19.3%. Rates and extents of ruminal protein degradation, estimated by the inhibitor in vitro method, were 0.17, 0.04, 0.01 and 0.01/h and 74, 42, 15 and 14% of total CP, for SSBM, ESBM, BM and CGM, respectively. Rumen and omasal samples also were collected to determine the rates and extents of protein degradation in vivo. Yield of milk and milk components and DMI all were increased compared to the Control. Milk yield was higher for cows fed ESBM and CGM, milk fat yield was higher on SSBM and CGM, but milk protein yield was not significantly different among cows fed SSBM, ESBM, BM and CGM. Digestibility of NDF was higher on SSBM and BM.

Item	Control	SSBM	ESBM	BM	CGM	SEM
DMI, kg/d	21.7 ^a	23.5 ^{bc}	23.8 ^c	22.8 ^b	23.6 ^{bc}	0.6
BW gain, kg/d	0.39 ^{ab}	0.55 ^{ab}	0.16 ^a	0.59 ^b	0.36 ^{ab}	0.15
Milk Yield, kg/d	32.9 ^a	36.5 ^b	37.9 ^c	37.7 ^{bc}	38.5 ^c	1.2
Milk fat, kg/d	1.18 ^a	1.36 ^b	1.28 ^c	1.28 ^c	1.35 ^{bc}	0.04
Milk protein, kg/d	0.95 ^a	1.11 ^b	1.11 ^b	1.10 ^b	1.14 ^b	0.03
Rumen pH	6.18 ^a	6.09 ^{ab}	6.16 ^a	6.00 ^b	6.16 ^a	0.05
Rumen NH ₃ , mM	8.0 ^a	11.2 ^b	10.3 ^{bc}	9.9 ^c	9.1 ^{ac}	0.4
Rumen TAA, mM	3.11	3.47	2.98	3.20	2.81	0.25
NDF intake, kg/d	6.25 ^a	6.71 ^{bc}	6.89 ^c	6.54 ^b	6.58 ^b	0.16
NDF digestibility, %	40.9 ^a	48.2 ^b	43.7 ^a	45.8 ^b	43.9 ^a	1.2

^{a,b,c}Means with different superscripts differ (P<0.05). NH₃= Ammonia, TAA= Total Amino Acids

Key Words: Dairy cows, Ruminal protein degradation, Protein supplements

1250 Effects of diet protein level and abomasal amino acid infusion on phenylalanine and tyrosine metabolism in lactating dairy cows. C. K. Reynolds*¹, L. A. Crompton¹, B. J. Bequette², J. France¹, D. E. Beever¹, and J. C. MacRae², ¹University of Reading, UK, ²Rovett Research Institute, Aberdeen, UK.

The objective was to measure effects of diet protein level and abomasal amino acid infusion on kinetic transfer of Phe and Tyr across splanchnic tissues in 6 multiparous, catheterized, rumen cannulated, mid-lactation Holstein x Friesian cows (667 kg BW). Measurements were made on the last day of 4-d abomasal water (18 L/d) and 6-d abomasal essential amino acid (EAA equal to 800 g milk protein/d) infusions. Cows were fed one of 2 concentrates (109 g [LO] or 203 g [HI] crude protein/kg DM) in a split-plot design with 5-wk periods. Dehydrated lucerne, grass silage and concentrate (330, 170 and 500 g/kg DM, respectively) were fed hourly at 95 % of ad libitum DMI. 1-¹³C-Phe and ²H₄-Tyr were infused into a jugular vein beginning 3.5 h before hourly measurements (4) of portal-drained viscera (PDV) and liver (LIV) blood flow and kinetic

flux (mmol/h) of Phe, Tyr and CO₂ were obtained. Intake of DM was lower ($P < 0.04$) for LO (21.5 vs. 22.4 kg/d), but milk yield was not affected (30.3 kg/d, $P > 0.11$). Body irreversible loss of Phe (48 vs. 63) and Tyr (38 vs. 43) and Phe hydroxylation (2.5 vs. 5.0) were increased ($P < 0.01$) by E800. Gross PDV Phe uptake was increased ($P < 0.02$) by HI (12 vs. 14) and E800 (11 vs. 15). Gross PDV Phe release was increased by E800 (44 vs. 63, $P < 0.01$) and tended to increase for HI (51 vs. 57, $P < 0.10$). There was no measurable PDV Phe oxidation or hydroxylation. Gross LIV Phe uptake (35 vs. 50) and oxidation (15 vs. 27) were increased ($P < 0.01$) by E800, whilst LIV Phe hydroxylation ($P < 0.03$) was increased by E800 for LO (1.7 vs. 4.0) and decreased by E800 for HI (7.2 vs. 4.4). Gross LIV Phe release (12) was not affected ($P > 0.73$). Gross Tyr uptake (10 and 29) and release (37 and 12) by PDV and LIV, respectively were not affected ($P > 0.08$). Increased gross PDV release of Phe accounted for 99 % of Phe in E800, whilst on a net basis the recovery was 77 %. This illustrates the extent to which net PDV flux underestimated Phe absorption and suggests little loss of Phe during absorption.

Key Words: Splanchnic, Cows, Phenylalanine

1251 Effects of diet protein level and abomasal amino acid infusions on splanchnic metabolism in lactating dairy cows. C. K. Reynolds^{*1}, B. Lupoli¹, P. C. Aikman¹, J. A. Benson¹, D. J. Humphries¹, L. A. Crompton¹, J. France¹, D. E. Beever¹, and J. C. MacRae², ¹University of Reading, UK, ²Rowett Research Institute, Aberdeen, UK.

The objective was to measure effects of diet protein level and abomasal amino acid infusion on splanchnic metabolism in 6 multiparous, catheterized, rumen cannulated, mid-lactation Holstein x Friesian cows (667 kg BW) fed one of 2 concentrates (109 [LO] or 203 [HI] g crude protein/kg DM). Cows received 4-d abomasal infusions (18 L/d) of water followed by essential amino acids (EAA) equal to 800 g milk protein/d for 6 d in a switch-back experiment with 5-wk periods. Dehydrated lucerne, grass silage and concentrates (33, 17 and 50 %, respectively, on a DM basis) were fed hourly at 95 % of ad libitum DMI. Hourly measurements (6) of splanchnic (portal-drained viscera [PDV] and liver [LIV]) blood flow and net nutrient flux (mmol/h) were obtained on the last day of water and treatment infusions. Intake of DM was decreased ($P < 0.04$) by LO (21.5 vs. 22.4 kg/d), but milk yield was not affected (30.3 kg/d, $P < 0.11$). Milk protein (g/kg) was increased ($P < 0.01$) by EAA (35.4 vs. 36.3). Blood flow for PDV and LIV (1897 and 2377 L/h, respectively) were not affected by diet ($P > 0.12$) or EAA ($P > 0.06$). Net PDV release of ammonia was increased by HI (636 vs. 770, $P < 0.01$). Net LIV release of acetate was decreased by EAA (1055 vs. 391, $P < 0.02$). Net LIV removal of ammonia (663 vs. 824, $P < 0.02$) and release of urea (390 vs. 575, $P < 0.04$) were increased by HI. Infusion of EAA increased net PDV release of total EAA (265 vs. 327, $P < 0.03$). The recovery of infused EAA as increased net PDV release averaged 48 % and ranged from 16 (Val) to 83 (Arg) %. Increased splanchnic release was 6 (LO) and 35 (HI) % of total EAA infused. Net PDV release (308 vs. 344) and LIV removal (217 vs. 261) of total nonessential amino acids (NEAA) was increased by HI ($P < 0.05$). The net recovery of infused EAA as increased PDV release was not affected by diet protein level and was relatively low, but net flux does not account for increased EAA removal from arterial blood.

Key Words: Splanchnic, Cows, Amino acids

1252 Splanchnic metabolism of gut peptides in dairy cows abomasally infused with long chain fatty acids at two stages of lactation. J. A. Benson^{*} and C. K. Reynolds, University of Reading, UK.

Effects of a 7 d abomasal infusion of long chain unsaturated fatty acids (LCFA) on arterial concentration (pmol/ml) and splanchnic metabolism (portal-drained viscera [PDV] and liver [LIV]; nmol/h) of hormones were measured in 6 Holstein x Friesian cows (673 kg BW) at a mean of 55 (ELAC) and 100 (MLAC) d lactation. Pancreatic glucagon (PAN), gut glucagon (GUT), glucagon-like peptide-1 (7-36) amide (GLP-1) and cholecystokinin-8 (CCK) were measured by RIA. Daily DMI was decreased by LCFA (22.8 vs 21.5 kg/d, $P < 0.01$) but was unchanged between lactation stage ($P > 0.6$). Milk yield was unaffected by LCFA infusion ($P > 0.13$) but was greater in ELAC (40.0 vs 35.1 kg/d, $P < 0.01$). Arterial PAN concentration was greater in MLAC (0.113 vs 0.090, $P < 0.01$), the result of increased PDV PAN release (38.8 vs 28.3, $P <$

0.04) and reduced LIV PAN uptake (5.8 vs 11.1, $P < 0.07$) in MLAC. Arterial concentration and PDV PAN release were unaffected ($P > 0.2$) by LCFA but LIV uptake of PAN was increased (11.6 vs 5.3, $P < 0.03$). Neither PDV or LIV GUT metabolism was affected by LCFA or stage of lactation ($P > 0.23$) but arterial concentration (0.36 vs 0.30, $P < 0.09$) and total splanchnic (TSP) output (42.7 vs 24.9, $P < 0.10$) of GUT were increased by LCFA. Arterial concentration (0.057 vs 0.051, $P < 0.01$) and PDV release (5.6 vs 2.8, $P < 0.03$) of GLP-1 were also increased by LCFA. There was no significant net GLP-1 flux across LIV but periods of uptake or release were evident. Arterial concentration (0.057 vs 0.052, $P < 0.02$) and TSP release (6.5 vs 4.7, $P < 0.1$) of GLP-1 were greater in ELAC. Arterial CCK concentration was greater in ELAC (0.025 vs 0.019, $P < 0.01$) due to less LIV CCK uptake (1.2 vs 5.3, $P < 0.1$). Net TSP release and arterial CCK concentration were unaffected by LCFA infusion ($P > 0.31$). The results show the liver's important role in determining circulating hormone concentrations and suggest unsaturated fatty acids stimulate the release of GUT and GLP-1 by splanchnic tissues, but not CCK.

Key Words: Gut peptides, Splanchnic, Fatty acids

1253 Evaluation of Molly, a dynamic, metabolic model of a dairy cow for predicting milk production. H.A. Johnson^{*}, R.L. Baldwin, and D. Meyer, University of California, Davis.

Data from 3 cows in a nitrogen (N) balance study were used to evaluate estimates of N intake and excretion by MOLLY. MOLLY is a dynamic, mechanistic model of dairy cow metabolism and digestion written in the advanced continuous simulation language (ACSL). Cows were fed two diets in a crossover design. The first diet was 21.7% beet pulp, 18.3% whole cottonseed, 13.3% rolled barley, 10.3% molasses, 8.4% almond hulls, 3.3% soybean meal 3% mineral mix 1.7% fat and 20% flaked corn. Diet 2 was the same except flaked corn was replaced with rolled corn. Cows were adjusted to the diets for 7 days and then feed intake, milk production and total urine and feces data were collected for 5 days for a total of two collection periods per cow (one for each diet). The model was calibrated to replicate total milk and total N intake for each cow for the first 5 day period. Then the model was used to predict N excretion in the first and second periods. Average N intake of observed data were 0.541 kg/d (SE=0.030) and average N excretion of observed data were 0.206 kg/d in urine (SE=0.013), 0.201 kg/d in feces (SE=0.016) and 0.143 kg/d in milk (SE=0.0063). Predicted parameters were regressed on observed data to determine correlation coefficients for an index of goodness of fit of model predictions to the data. The model was able to predict N excretion in urine (R^2)=0.70, mean bias=0.015 kg/d) and milk (R^2)=0.75, mean bias=-0.0080 kg/d) but over predicted N in feces (R^2)=0.22, mean bias=0.015 kg/d).

Key Words: Nitrogen Balance, Model Evaluation, Metabolic Dairy Cow Model

1254 Effect of duodenal infusion of α -ketoglutarate (α -KG) on nitrogen metabolism of dairy cows. F. Rossi¹, L. Fiorentini¹, H.G. Jungvid², and G. Piva^{*1}, ¹Istituto di Scienze degli Alimenti e della Nutrizione, Facolt di Agraria, Piacenza, Italy, ²Gramineer International AB, Lund, Sweden.

Two dry Friesian cows were duodenally infused alternatively with: sterile water (control); α -KG (60g/d); lysine (27.6 g/d) plus methionine (9.20 g/d). The animal received a diet made up with (as fed): grass hay 7 kg, corn silage 5 kg, barley straw 2 kg. α -KG was prepared as stock solution (100 ml of water, 30 g of α -KG, 9.6 g of NaOH) and given as a 5% water solution continuously infused for 9 hours. Blood samples were taken every hours starting before morning meal and analyzed for urea, glucose and amino acids content. Compared to control the infusion of α -KG reduces the amino acids catabolism as indicated by the lowering of the average urea plasma level (-24.7%, $P < .01$), the effect is similar to the one obtained when infusing lysine and methionine (- 21.7%, $P < .01$), suggesting that α -KG supplementation can improve the amino acids balance. No effect was detected on the glucose level, probably due to the strong homeostatic regulation of this parameter. By infusing α -KG the plasma EAA concentration was increased (22.4%) 6 hours from feeding compared to the 0 hour sample, whereas there was a decrease of the ratio (9.1%) when infusing distilled water. The plasma EAA concentration was also increased when infusing lys+met (30%). The increments of the single amino acids 6 hours after the infusion were higher, compared to the control, either when infusing α -KG or lys+met. When α -KG was

administered the major increments were observed for Thr (35.9%), Lys (31.0%). Arginine concentration also increased (15.7%) probably because it is a precursor of urea. When infusing α -KG there is a decrease of urea excretion and, as the arginine is involved in the urea cycle, this could reduce the need for the amino acid. The increased lysine and threonine plasma concentrations could partially be accounted for by a reduction of amino acids catabolism.

Key Words: Cow, Urea, α -ketoglutarate

1255 Estimating the undegradability of intake protein using duodenal flows: a literature study. R. A. Patton*¹ and M. J. Stevenson², ¹Nittany Dairy Nutrition, Mifflinburg, PA, ²Degussa Hüls Canada, Burlington, ON, Canada.

The amount of protein that escapes rumen degradation and is delivered to the intestine for absorption is important if amino acids are to be accurately evaluated in dairy cattle diets. One way to estimate the UIP of feedstuffs is to measure the amount of feed protein flowing to the duodenum and then back calculate the degradability of each protein. We reviewed 44 studies representing 177 diets (104 lactating dairy cow and 73 growing beef cattle diets) in which feed intake and duodenal flow of dietary and microbial protein were reported. We assumed feedstuff UIP values were relative and computed a diet UIP factor (=measured duodenal feed protein / UIP calculated from standard values). Degradability estimate=standard UIP %CP * diet UIP factor. Mean UIP predictions are presented, as reported and corrected for endogenous protein flow. All degradability estimates had high SE. Degradability of the diet was unrelated to DMI or DMI as a % of BW. Steer diets had significantly lower undegradability factors (1.00 and 0.64) than dairy diets (1.50 and 1.34) for unadjusted and adjusted factors respectively (P<.10 and P<.01). Adjusted UIP estimates were slightly greater than those in the Mepron model. Although SE is high, this work generally supports published UIP values.

Feed	No	Std Estimate		Corrected		
		UIP	Estimate	SE	UIP	SE
Alfalfa hay	62	28	35.4	11.9	30.1	11.6
Alfalfa silage	45	23	28.9	8.2	26.3	8.0
Grass hay	15	30	39.1	12.5	36.4	11.8
Corn silage	91	30	45.4	11.3	39.9	11.7
Grd shell corn	86	50	71.7	20.9	61.7	22.4
Cracked corn	25	55	64.1	19.8	54.8	21.4
Corn glut meal	19	65	74.3	20.3	65.4	20.2
Blood meal	28	80	108.7	32.7	98.5	32.8
Canola meal	10	30	32.1	6.0	27.9	7.2
Fish meal	18	60	81.3	21.0	73.4	21.5
Soybean ml 48	95	30	42.7	12.0	37.5	11.9
Raw soybean	6	25	47.0	5.6	42.1	7.7
Roast soybean	12	50	47.2	16.5	38.5	5.9
Whole cotton	18	40	54.3	19.3	43.9	18.3

Key Words: rumen undegradable protein, feed degradability, DMI

1256 Molecular cloning, in vitro expression, and functional characterization of an ovine gastrointestinal peptide transporter (oPepT1). Y. Pan*, E. A. Wong, J. R. Bloomquist, and K. E. Webb, Jr., Virginia Tech, Blacksburg.

We have determined the primary structure, tissue distribution, and in vitro functional characteristics of a peptide transporter, oPepT1, from ovine intestine. The ovine intestinal oPepT1 cDNA was 2,829 bp long encoding a protein of 707 amino acid residues with an estimated molecular size of 79 kDa, and a pI of 6.57. The cDNA contained a 79-bp 5' untranslated sequence and a 630-bp 3' untranslated sequence. The proposed oPepT1 protein was 77.9, 81.3, and 82.6 percent identical to PepT1 from rabbit, rat, and human, respectively. High stringency northern blot analysis demonstrated that oPepT1 is expressed strongly in the small intestine, at lower levels in the omasum, and at much lower levels in the rumen, and is not expressed in liver or kidney. The presence of the peptide transporter in the forestomach at such levels could provide amino acid nitrogen in the form of short peptides for the ruminant in a nutritionally significant manner. Transport function of oPepT1 was assessed by expressing oPepT1 in *Xenopus* oocytes using a two-electrode voltage-clamp technique. Overall, the in vitro transport characteristics of oPepT1 expressed in oocytes were similar to those of PepT1 from

other species. The transport process is electrogenic and pH-dependent, but independent of Na⁺, Cl⁻, and Ca²⁺. It displayed a broad substrate specificity that transported neutral and charged dipeptides and tripeptides. All dipeptides (10) and tripeptides (4) examined evoked inward currents in a saturable manner, with an affinity constant (K_t) ranging from 20 mM to 3.0 mM for peptides. No responses were detected from tetrapeptides (4) or free amino acids.

Key Words: Peptide, Transport, Sheep

1257 Transport of peptides in CHO cells expressing the cloned ovine gastrointestinal peptide transporter (oPepT1). H. Chen, Y. Pan, E. A. Wong, J. R. Bloomquist, and K. E. Webb, Jr., Virginia Tech, Blacksburg.

Chinese hamster ovary cells (CHO) expressing our cloned ovine gastrointestinal peptide transporter (oPepT1) were used to investigate oPepT1-mediated absorption of peptides in mammalian cells. The CHO cells were transfected with an expression vector containing the oPepT1 cDNA. Transport was assessed by uptake studies using the radiolabeled dipeptide, [³H]-Gly-Sar. Expression of oPepT1 was detected by 8 h post-transfection with maximum expression occurring by 16 h. Uptake of [³H]-Gly-Sar showed that the transport process is pH-dependent with an optimal pH of 5.5. Gly-Sar uptake is also concentration-dependent and saturable with an apparent K_m of 3.8±0.8 mM and a maximum velocity of 1,350 pmol · 2x10⁵ cells⁻¹ · 20 min⁻¹. These results were similar with those obtained from *Xenopus* oocytes expressing oPepT1. Competition studies with three non-radiolabeled dipeptides (Met-Gly, Met-Met, and Lys-Lys) and two non-radiolabeled tripeptides (Leu-Gly-Gly and Lys-Trp-Lys) with [³H]-Gly-Sar showed that all these peptides inhibited the uptake of [³H]-Gly-Sar. Substrate affinities of these peptides were similar to those observed in *Xenopus* oocytes expressing oPepT1. In addition, two tetrapeptides (Met-Gly-Met-Met and Pro-Phe-Gly-Lys) inhibited the uptake of [³H]-Gly-Sar, whereas these two tetrapeptides were not transported in oocytes expressing oPepT1. The reason for this difference is under investigation. There was no inhibition of [³H]-Gly-Sar uptake when non-radiolabeled free amino acids were used as a competitor.

Key Words: Peptide, Transport, CHO

1258 Determination of enzyme secretion from bovine pancreas using an in vitro tissue model. K. C. Swanson*, J. C. Matthews, C. J. Richards, and D. L. Harmon, University of Kentucky, Lexington.

An in vitro pancreatic tissue model was developed to evaluate the relative sensitivity of bovine pancreatic tissue to neurohormonal mimics and substrates. Steers (150 to 200 kg BW) fed a hay-based diet were overdosed on sodium pentobarbital and the pancreata removed and rinsed with and transported to the lab in ice-cold saline (.9% NaCl). A portion from the central region was cut into small pieces (approximately 2 × 2 mm) with scissors in ice-cold Krebs's Ringer Bicarbonate buffer (KRB). Tissue pieces (100 to 200 mg) were incubated in capped 25-mL flasks containing 3 mL of oxygenated KRB in a 39C shaking water bath. After incubation, flasks were placed on ice and the buffer removed and stored at -30C until analysis for α -amylase and trypsin (after activation with 200 U/L enterokinase) activities. Preliminary experiments indicated that secretion of α -amylase increases (P<.01) linearly with incubation time from 30 to 180 min. Tissues were challenged for 60 min, following a 60-min pre-incubation (in the presence of substrates), with control (KRB), 100 nM caerulein (CCK mimic), or 10 μ M carbachol (acetylcholine analog) to determine if substrate addition interacts with neurohormonal challenge to influence α -amylase and trypsinogen secretion (experiment replicated 3 times). Substrate treatments were: 1) control (no additions), 2) 3.3 mM glucose and 5 mU insulin, 3) minimal essential amino acid mixture (Gibco), .26 mM glutamine, and 5 mU insulin, and 4) VFA (2 mM acetate, .5 mM propionate, .2 mM isobutyrate, .4 mM butyrate, .05 mM 2-methyl butyrate, .10 mM 3-methyl butyrate, and .15 mM valerate). α -Amylase and trypsin secretion increased (P<.01) with caerulein and carbachol challenge. Trypsin secretion increased (P<.06) when amino acids or VFA were included as a substrate. These data indicate that pancreatic tissue prepared as described will respond to neurohormonal or substrate challenge. This procedure may prove useful for evaluating factors mediating nutritional adaptation of pancreatic enzyme secretion in cattle.

Key Words: pancreas, in vitro, bovine

1259 Estimating the uptake of circulating free and peptide-bound Methionine and Leucine by the udder of goats at two stages of lactation. S. J. Mabweesh^{*1}, C. E. Kyle², J. C. MacRae², and B. J. Bequette², ¹Hebrew University of Jerusalem, Israel, ²Rowett Research Institute, Scotland.

An arterio-venous (A-V) kinetic technique was used to monitor mammary amino acid (AA) metabolism in goats (n=4) at two stages of lactation (80 ± 17 vs. 233 ± 14 DIM) in response to an i.v. infusion of Lys plus Met. At both stages, [5-¹³CH₃]Met and [5,5,5-²H]Leu A-V kinetics were performed on the last day of 5-d i.v. infusions of saline followed by Lys (9 g/d) plus Met (2 g/d; LM). At both stages of lactation, there was sufficient net uptake of blood free Met and Leu by the udder to account for their secretion in milk. It was estimated from isotope dilution, however, that circulating peptides contributed 8 and 17% of Met and 12 and 27% of Leu used for casein synthesis in early vs. late lactation, respectively. And, for both AA, the contribution of peptides was highest ($P < 0.001$) in late lactation. Thus, when both free AA and peptides are considered, there appears to be considerable excess (up to 65%) uptake by the udder of Met and Leu. Depending upon treatment and stage of lactation, net uptake of free AA from blood differed ($P < 0.05$) from plasma for Met, Lys and Thr. And, for Ala and Lys, the ratio of mammary net uptake to output in milk was higher ($P < 0.05$) in late lactation. These data provide the first systematic comparisons of circulating free AA and peptide removals by the udder of goats at different stages of lactation.

Key Words: mammary gland, amino acid, peptide

1260 Effect of ruminally protected betaine on the productivity of Angora goats. T. Shenkoru^{*1}, F.N. Owens², R. Puchala¹, T. Sahlul¹, and E. Virtanen³, ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Animal Science Department, Oklahoma State University, Stillwater, ³Cultor, Helsinki, Finland.

Twenty-five Angora wethers (20 ± 2 kg initial BW and 7 mo of age) were used to evaluate effects of ruminally protected betaine (PB) on ADG, ruminal fermentation endproducts, and mohair quality and production. Animals were randomly allocated to five treatments and had ad libitum access to a 53% concentrate diet (15% CP) for 90 d beginning in September. Treatments were no added betaine (C), 6 g/d of unprotected betaine (UPB), and 2, 4, and 6 g/d of PB (2PB, 4PB, and 6PB, respectively). In a separate experiment, ruminal disappearance of UPB was complete at 2 h of incubation and total tract digestibility of PB was 76%. Dry matter intake and feed efficiency were similar among treatments ($P > .10$). Average daily gain was greatest ($P < .06$) among treatments for 6PB (45, 46, 29, 56, and 82 g/d for C, UPB, 2PB, 4PB, and 6PB, respectively; SE = 8.8). No differences were observed in greasy and clean fleece weights ($P > .10$). There was a treatment x 4-wk period interaction in mohair length. Mohair length at first harvest in October was similar among treatments. In November length was greater ($P < .02$) for 6PB than for C and UPB (25, 25, 27, 28, and 29 mm; SE = .06); whereas, December mohair tended ($P < .06$) to be longer for 6PB than for C and UPB (21, 21, 21, 24, and 26 mm for C, UPB, 2PB, 4PB, and 6PB, respectively; SE = .07). Ruminal concentration of total VFA and the acetate to propionate ratio were similar among treatments ($P > .10$). In conclusion, these results suggest that dietary supplementation with 6 g/d ruminally protected betaine may enhance ADG and mohair length of Angora goats.

Key Words: Betaine, Mohair, Angora goats

1261 Influence of raw and dry roasted whole lupin seeds (*lupinus angustifolius*) and whole faba beans (*vicia faba*) as protein supplements on performance of growing lambs. P. Yu^{*}, B.L. Leury, M. Sprague, L. Boon-ek, and A.R. Egan, University of Melbourne, Australia.

Forty second-cross growing female lambs ([Border Leicester (M) × Merino (F) → F1 (F) × Poll Dorset (M)]; 6 months; 34.9 ± 2.1 kg liveweight) were used to study the effects of dry roasting of whole lupin seeds (WLS) and whole faba beans (WFB) on performance and carcass quality. Lambs were fed a fixed quantity of oaten and lucerne chaff plus a daily supplement of either: (1) no legume seeds; (2) raw WLS; (3) roasted WLS; (4) raw WFB; (5) roasted WFB. Seeds were dry roasted at 150°C for 45 min. All diets were isonitrogenous (15.9% CP). Diets in

supplement group, about 55% of protein was supplied by WLS or WFB protein. Diets with roasted seeds and diets with raw seeds were isoenergetic. Supplementation improved lambs performance: ADG ($p < 0.05$) and gain:feed ratio ($p < 0.05$) and the effect was greater in the lambs fed WFB than that fed WLS. The major reasons could be attributed to differences in the net truly absorbable protein in the small intestine (DVE), ME and/or absorbable bypass starch (ABSt). Dry roasting of WLS and WFB tended to increase ADG ($p < 0.1$) and gain:feed ratio ($p < 0.1$) of lambs fed moderate quality roughage and this effect seemed to be mainly mediated through a decrease in ruminal CP and/or starch degradability of the roasted seeds and increased intestinally absorbed protein (DVE values) and starch (ABSt). The predicted live-weight changes (ΔW) from known intakes of DM and ME were all higher than the observed ADG. This could be because supplies of the truly absorbed intestinal protein in diets (total DVE intakes) did not meet predicted requirements for support of the predicted/target ΔW values. However, in terms of the purpose in this study, which was not to obtain a maximum growth rate but to detect effectiveness of dry roasting on animal performance, probable limiting in DVE supplies might play an important role in detecting the effectiveness of dry roasting on animal performance.

Key Words: Lamb Performance, Legume Seeds, Dry Roasting

1262 Using the DVE/OEB model to determine optimal conditions of pressure toasting on horse beans (*vicia faba*) for dairy feed industry. P. Yu^{*}, J.O. Goelema, and S. Tamminga, Department of Animal Nutrition, Wageningen Agricultural University, The Netherlands.

The effects of pressure toasting (100, 118 and 136°C for 3, 7, 15 and 30 min) on potential ruminant protein nutritional values in terms of: a), rumen bypass protein (BCP); b), rumen bypass starch (BSt); c), fermented organic matter (FOM); d), true absorbed BCP (ABCP); e), microbial protein synthesized in the rumen based on available energy (E_{MP}); f), microbial protein synthesized in the rumen based on available N (N_{MP}); g), true protein supplied to the small intestine (TPSI); h), true absorbed rumen synthesized microbial protein (AMP); i), endogenous protein losses (ENDP); j), true digested protein in the small intestine (DVE); k), degraded protein balance (OEB) of horse beans were evaluated by the new Dutch protein evaluation system: the DVE/OEB model. Pressure toasting significantly increased BCP, BSt, TPSI, ABCP, DVE ($P < 0.001$) and decreased FOM, E_{MP}, AMP, N_{MP} and OEB ($P < 0.001$) with increasing temperatures and times. The values of BCP, BSt, TPSI, ABCP and DVE at 136°C/15 min were highly increased 3.1, 1.9, 1.7, 3.3 and 1.9 times and the values of FOM, E_{MP}, AMP, N_{MP} and OEB at 136°C/15 min were greatly decreased by 28.7, 30.9, 29.0, 49.0 and 69.0%, respectively, over the raw horse beans. The OEB values were significantly reduced ($P < 0.001$) but not to the level of negative, which indicated that microbial protein synthesis might not be impaired due to the sufficient N supplied in the rumen, but the high positive OEB values in the most treatments except of 136°C for 15 min (The OEB values: 31.9 g/kg DM) indicated that there were the large amounts of N loss in the rumen. It was concluded that pressure toasting at high temperature was effective in shifting protein degradation from rumen to intestines and it increased the DVE values without reaching the negative OEB values. The treatments of 100°C/7, 15 or 30 min, 118°C/3, 7, 15 or 30 min and 136°C/3 or 7 min were not sufficient to reduce N-loss in the rumen due to the too high OEB values. But pressure toasting at 136°C/15 min might be optimal treatments for horse beans due to its high DVE and very low OEB values.

Key Words: DVE/OEB Model, Horse Bean, Pressure Toasting

1263 Effect of the substitution of safflower meal by chickpeas on organic matter digestibility and digestible energy value of finishing diets for sheep. R. Barajas^{*}, J.F. Obregon, and A. Estrada, Universidad Autonoma de Sinaloa.

A crossover experiment was conducted to determine the effect of substituting safflower meal with chickpeas on total tract digestibility of organic matter, crude protein, and energy of finishing diets for sheep. Four Pelibuey sheep (30.8 kg) were assigned to dietary treatments: 1) Control: 15.7% CP and 2.81 Mcal DE/kg, containing (DM basis) 30% of safflower meal, 38% ground sorghum grain, 20% alfalfa hay, 10% sugarcane molasses, 0.6% of urea and 1.4% of mineral premix; and 2) Diet similar to control diet but substituting safflower meal with ground chickpeas. The dry matter (DM) and organic matter (OM) intake were not

affected ($P > 0.60$) by treatments. Mean DM intake was 1.04 kg/day (3.38% of initial body weight). Fecal excretion decreased ($P < 0.01$) by 47% for DM (346 vs 183 g/d) and by 50% for OM (314 vs 156 g/d) for the chickpea diet. The inclusion of chickpeas, increased ($P < 0.01$) total tract digestibility of DM (66.8 vs 82.6%) by 23.6%, and total tract digestibility of OM (67.6 vs 83.9%) by 24.1%. Fecal excretion of CP and digestibility of CP were not affected ($P > 0.10$) by treatments. Chickpeas increased ($P < 0.01$) digestible energy content of the diet (2.76 vs 3.54 Mcal/kg) by 28%. Using the reference the value of 84% for true digestibility for safflower meal CP, the true digestibility of CP for chickpeas was 95%. Chickpeas are a better crude protein supplement than safflower meal in finishing diets for sheep.

Key Words: Chickpeas, Safflower meal, Sheep

1264 The substitution of canola meal by chickpeas as protein supplement in finishing diets for sheep: effect on apparent digestibility. J.F. Obregon*, R. Barajas, and A. Estrada, *Universidad Autonoma de Sinaloa*.

The objective was to determine the effect of substituting canola meal with chickpeas on total tract digestibility of organic matter, crude protein and energy of finishing diets for sheep. Four Pelibuey sheep (22.5 kg) were used in a digestion trial with a crossover design. The dietary treatments were: 1) Control: 20.4% CP and 3.25 Mcal DE/kg, containing (DM basis) 30% canola meal, 36% ground sorghum grain, 20% alfalfa hay, 12% of sugarcane molasses, 0.6% of urea and 1.4% of mineral premix; and 2) Diet similar to control except substitution of canola meal with ground chickpeas. The dry matter (DM) and organic matter (OM) intake were not affected ($P > 0.60$) by treatments. Mean DM intake was 0.829 kg/d and represented 3.69% of initial weight of sheep. Fecal excretion of DM, OM, and CP decreased ($P < 0.05$) 21% with chickpeas compared to control. Mean values for fecal output of DM, OM, and CP were 176 vs 139 g/d; 150 vs 119 g/d; and 42 vs 33 g/d for control or chickpeas respectively. The inclusion of chickpeas, increased ($P < 0.01$) total tract digestibility of DM by 6.4% (78.23 vs 82.3%); improved total tract digestibility of OM by 6.6% (79.8 vs 85.1%); and enhanced ($P = 0.02$) the apparent crude protein digestibility in diets by 2.2% (76.82 vs 78.47%). The digestible energy content (DE) of the diet increased ($P < 0.01$) by 7.6% with chickpeas (3.35 vs 3.60 Mcal/kg). Taken as reference the value of 88% of true digestibility for canola meal-CP, the true digestibility of CP of chickpeas was 97%, and its value of digestible energy content was calculated as 4.11 Mcal/kg. It is concluded, that chickpeas have a better nutritional value as a crude protein supplement than canola meal in finishing diets for sheep.

Key Words: Chickpeas, Canola meal, Sheep

1265 Nitrogen metabolism of beef steers fed endophyte-free fescue hay: effects of rumen protected methionine supplementation. S. L. Archibeque*, J. C. Burns, and G. B. Huntington, *North Carolina State University, Raleigh*.

Level of nitrogen (N) intake and rumen protected methionine supplementation were evaluated in 8 Angus growing steers (initial weight 253 \bar{n} 21 kg, final weight 296 \bar{n} 21 kg). In a replicated, 4x4 latin square design, the steers were fed two endophyte-free fescue (*Festuca arundinacea*) hays that were either high (HI) (2.8% DM) or low (LO) in N (2.2% DM) and were either supplemented or not with rumen protected methionine¹ (10 g metabolizable methionine/d). Diets were fed to provide adequate energy for 0.5 kg ADG and sufficient protein for maintenance (LO), or 0.5 kg ADG (HI). Following at least 14 d of adjustment, N balance was measured for 6 d. Jugular blood was collected during the balance trial and serum was analyzed for blood urea N (BUN). By design, daily N intake was less ($P < 0.05$) for LO (89 g) than HI (112 g). HI differed from LO ($P < 0.05$) in daily DMI (4217 vs. 4151 g), urine N (48.3 vs. 37.5 g), fecal N (34.4 vs. 31.1 g), N retained (29.8 vs. 21.1 g), N digested (77.1 vs. 57.7 g), and urine urea N excretion (34.6 vs. 24.8 g). HI also differed ($P < 0.05$) from LO in urine urea N concentration (276 vs. 219 mM), BUN (8.7 vs. 6.7 mM), N digestibility (69.1 vs. 64.9%), and percentage of urinary N present as urea (71.5 vs. 66.7%, $P = 0.053$). Methionine supplementation tended to decrease daily urine N (44.6 vs. 41.2 g, $P = 0.102$), and tended to increase both the amount of N retained daily (23.4 vs. 27.5 g, $P = 0.089$) and the percentage of dietary N digested by the steers that was retained (34.6 vs. 40.4%, $P = 0.094$). In summary, supplemental methionine met a specific dietary limitation by

increasing the amount of N retained within the steers by decreasing the amount of N lost in the urine.

Key Words: Beef Steers, Forage, Methionine

1266 Effect of nitrogen source in high-concentrate diets on microbial fermentation in vitro. M. Devant, A. Ferret*, S. Calsamiglia, R. Casals, and J. Gasa, *Universitat Autonoma de Barcelona*.

Eight dual-flow continuous culture fermenters (1327 mL) were used in two consecutive periods to study the effects of nitrogen source on microbial fermentation. A 2 x 2 factorial arrangement of treatments was designed. Factors were protein source (soybean meal, S, or a mixture of fish meal and corn gluten meal, FC) and the partial substitution of protein source by urea (without vs with, U). Solid (5.9 %/h) and liquid (9.6 %/h) passage rates, and pH curve (average 6.25) obtained in a previous in vivo study conducted with the same diets were used. Fermenters were maintained at 39 ° C and were fed continuously a 12 to 88 barley straw to concentrate diet (12.3% CP). True OM digestion, total VFA concentration, molar percentage of acetate and ammonia N concentration were, 53, 51, 48, 49%; 183, 169, 152, 169 mM; 45, 40, 38, 41 mol/100 mol; .95, .62, .51, and .63 mg/100 mL, for S, SU, FC, and FCU, respectively. Total VFA concentration ($P < .01$), molar percentage of acetate ($P < .05$) and ammonia N concentration ($P < .05$) were greater in S, followed by SU and FCU, and by FC. A significant protein source x urea interaction in these measurements was detected ($P < .05$). True OM digestion tended to increase ($P = .13$) in treatments containing soybean meal. Results suggest that amino N from soybean meal and ammonia N concentration stimulated nutrient digestion. Microbial protein synthesis was 1.31, 1.63, 1.18 and 1.38 g/d for S, SU, FC, and FCU, respectively. Microbial protein synthesis increased ($P < .01$) in treatments containing soybean meal and urea, indicating that rapidly available N limited microbial growth. Efficiency of microbial protein synthesis was 26, 33, 25, 30 g microbial N/kg OM truly digested for S, SU, FC, and FCU, respectively. Efficiency of microbial protein synthesis increased ($P < .001$) when treatments contained urea. Nitrogen degradability was 42, 54, 34 and 42% for S, SU, FC, and FCU, respectively. The low CP degradability may have limited aa and peptides supply for microbial growth.

Key Words: Microbial fermentation, Nitrogen source, Concentrate

1267 Influence of dietary metabolizable protein on production rates and N use by steers fed high grain content diets. R.H. Pritchard, C.J. Mueller*, K.W. Bruns, and S.J. Bierman, *South Dakota State University, Brookings*.

This study evaluated the effects of manipulating metabolizable protein (MP) levels on yearling steer performance and N use in a feedlot situation. Steers ($n = 120$; BW = 343 \pm 1.1 kg) were blocked into light (LBW; 323 kg) and heavy (HBW; 356 kg) BW groups, then allotted to one of three treatments for a 117d feeding period. Treatments were: LO) 11% CP fed throughout; HI) 13% CP fed throughout; and LHL) 11% CP fed from d 1 to 35, 13% CP fed from d 36 to 94 and 11% CP fed from d 95 to 117. Steers were fed a high grain diet (1.39 Mcal NEg/kg) throughout the trial and received an estradiol-trenbolone acetate implant on d 35. Metabolizable protein (estimated by NRC (1996)) allowed ADG were 1.5 and 1.8 kg for the LO and HI diets, respectively. Each treatment included 5 pens (2 LBW and 3 HBW replicates) with 8 steers per pen. When compared to the LO treatment the HI treatment improved gain efficiency (.163, .167 and .174 kg ; $P < .10$) and cumulative ADG (1.62, 1.68 and 1.75 kg; $P < .05$) for LO, LHL and HI, respectively. This resulted in heavier ($P < .10$) and fatter ($P < .05$) carcasses for HI vs LO. Interim growth performance was inconclusive. Serum urea-N concentrations were highest ($P < .05$) for cattle receiving the HI treatment across all periods. All treatments had an increase in serum urea-N within 56d of implant administration. Calculated total N intake increased ($P < .01$) from 18.8 to 21.3 to 23.1 kg per steer for LO, LHL and HI treatments, respectively. The N intake per 100 kg BW gain was higher ($P < .01$) for HI than LO treatments (9.89, 10.90, and 11.33 kg , respectively,) indicating a reduction in efficiency of N use with higher dietary levels of MP. The results of this experiment indicate that an increase in dietary MP can improve growth rates and efficiency, but may not result in improved efficiency of N use by the animal.

Key Words: Feedlot, Steers, Metabolizable protein

1268 Phosphorus balance throughout early lactation in dairy cows fed diets varying in phosphorus content. K.F. Knowlton*, W.A. Wark, and J.H. Herbein, *Virginia Polytechnic Institute and State University, Blacksburg.*

The effect of dietary phosphorus (P) on P balance throughout early lactation was evaluated in thirteen cows fed diets varying in dietary P content. All cows were fed a common TMR pre-partum (.28%P), followed by a common TMR for 7 days post-partum (.51%P). On day 7, cows were randomly assigned to one of three treatment diets containing .34 (no supplementary P), .52, or .67%P. Treatment diets differed only in dietary P content, and contained 18.3% CP, 15.8% ADF, 26.4% NDF, and .74% Ca. Total collections of milk, urine, and feces were conducted during weeks 3, 5, 7, 9, and 11 of lactation. Body weight (mean = 594.7 kg), milk yield (mean = 47.8 kg/d), and DMI (mean = 25.5 kg/d) were not affected by diet. With increasing dietary P, linear increases were observed in P intake (87.4, 133.7, and 171.7 g/d), fecal P (42.5, 86.3, and 113.0 g/d), urinary P (.32, 1.28, and 3.89 g/d), and total P excretion (42.8, 87.6, and 117.0 g/d). Apparent P digestibility decreased quadratically with increasing dietary P (51.1, 33.2, and 34.4% of P intake). Increasing dietary P did not affect P balance (-53.1, -50.1, -35.2 g/d). Increasing dietary P increased fecal and urinary P excretion in early lactation cows and did not improve P retention. We conclude that because bone mobilization in response to Ca needs in early lactation cows provides a readily available source of P, increasing dietary P content to meet the P needs of these cows may be redundant.

Key Words: Phosphorus Balance, Phosphorus Excretion, Early lactation cows

1269 Milk production and bone characteristics of dairy cows fed different amounts of phosphorus for two or three lactations. Z. Wu*¹, L. D. Satter¹, A. J. Blohowiak¹, R. H. Stauffacher¹, and J. H. Wilson², ¹*US Dairy Forage Research Center, USDA-ARS, and University Wisconsin, Madison*, ²*Virginia Polytechnic Institute & State University, Blacksburg.*

Effects of feeding different amounts of P to lactating dairy cows in the third year of a 3-yr feeding experiment are reported. Treatments were .31, .39, and .47% dietary P (DM basis) fed to 10, 14, and 13 Holsteins. The 37 cows included 19 and 14 that had been fed similar amounts of P for 2 or 3 yr, respectively, upon completion of the lactation this year; the remaining 4 cows (3 in the .31% and 1 in the .39% P groups) completed just the one lactation of this trial. The 12th rib bone was surgically removed (20 cm) from 9, 9, and 11 cows that were still available at the end of the lactation from the three treatments. The nine cows sampled from the .31% P group included the three 1-yr cows. The bone samples were tested for strength and P content. Milk production averaged > 12,000 kg during the lactation, with no indication that feeding low P reduced milk production. No difference was determined among treatments in the force the bone endured before rupture (shear stress) or the energy required to deform the bone to the point of fracture (fracture energy). Ash content of the bone was slightly lower for the .31% P group, but P content of bone ash was similar among treatments. Feeding .31 or .39% P for 2 or 3 yr did not reduce milk production, bone strength, or bone P content.

Item	.31% P	.39% P	.47% P	SEM
Milk, kg/308-d	13038 ^a	11909 ^b	12126 ^{ab}	407
Bone shear stress, N/mm ²	26.5	28.1	27.5	2.2
Bone fracture energy, N-mm	66552	60459	64952	4186
Bone ash, % of DM	53.9 ^c	56.2 ^a	55.6 ^{ab}	.8
Bone P, % of ash	17.7	17.3	17.9	.3
Bone thickness, mm	5.1	5.1	5.2	.1

^{a,b,c} b < a ($P < .05$) for milk yield, and c < a ($P < .06$) and c < b ($P < .13$) for bone ash.

Key Words: Milk, Phosphorus, Bone

1270 Effect of dietary Vitamin D and phosphorous intake on mineral excretion in dairy cattle. K.M. Dooley*, J.A. Bertrand, R.J. Thurston, A.B. Bodine, and T. Gimenez, *Clemson University, Clemson, SC.*

Phosphorous (P) excretion in manure is recognized as an environmental concern in the United States. The objective of this study is to reduce P excretion via increased intestinal absorption with the utilization of

supplementary Vitamin D. Two levels of phosphorous representing adequate and low values per the National Research Council (.41% and .31% DMI, respectively) were fed in conjunction with two levels, adequate (18,000 IU/d) and high (180,000 IU/d), of Vitamin D supplement in a 2x2 Latin square design experiment. Four Holstein cows of similar age and lactation were fed the assigned, rotated rations for an adjustment period of 24 days of each of four 28 day periods. The last four days of each period involved a total collection balance, weighing and sampling of milk, urine, and feces. Additionally, four blood samples were taken on day 28. Cows consumed a daily average of 17 Kg DM of a corn silage/grain ration containing 15.3% crude protein and 31 Mcal of NEL. Phosphorous levels in feces were affected by dietary phosphorous intake ($p < .05$) but not by Vitamin D ($p > .05$). Neither phosphorous intake nor Vitamin D were a main effect for milk or blood P ($p > .05$). Both phosphorous and Vitamin D indicated a trend in raising urine P ($p = .1$) with a significant interaction effect ($p < .05$). In feces, calcium levels were affected by Vitamin D ($p < .05$) and the calcium:phosphorous ratio was significantly different due to both P intake and Vitamin D ($p < .05$), while magnesium levels were not affected by either ($p > .05$). Milk yield, composition, calcium level or calcium:phosphorous ratio was also not significantly different among treatments. Excess Vitamin D does not appear to alter P absorption in dairy cattle. Dietary P at .31% DM for 590 KG lactating Holsteins did not reduce milk yield or alter milk components.

Key Words: Phosphorous, Vitamin D, Cows

1271 Effects of dietary iron on copper metabolism and milk production in Holstein and Jersey cattle. P. D. French*, R. E. James, M. E. Lissow, S. Nadir, and M. L. McGilliard, *Virginia Polytechnic Institute and State University, Blacksburg.*

An experiment was conducted to investigate the effects of dietary Fe on Cu status and milk production of Holstein and Jersey cows. Twelve Holstein and 12 Jersey multiparous cows (70 ± 4 days in milk) were assigned at random to diets containing 0 or 500 mg FeCO₃/kg DM in a 2 x 2 factorial plan. Diets contained (DM basis) 31% corn, 26% corn silage, 16% soy hulls, 12% whole cottonseed, 10% soybean meal, 2% animal-marine protein blend, and 3% mineral-vitamin. Diets were supplemented with 10 mg CuSO₄/kg DM and differed only in Fe supplementation. The basal diet contained 210 mg Fe and 9 mg Cu/kg DM. The experimental period was 90 d. Hepatic and plasma Cu, Fe, and Zn were determined on 0, 45, and 90 d samples. Holsteins receiving supplemental Fe consumed more DM and FeCO₃ than Jerseys receiving supplemental Fe, while breed intakes did not differ for cows receiving no supplemental Fe. Intake of Fe was similar for Holsteins and Jerseys receiving no supplemental Fe. Hepatic Cu did not differ for breeds (481 vs. 493 µg/g DM for Holstein and Jersey, respectively) or Fe supplementation (474 vs. 499 µg/g DM for 0 and 500 mg Fe/kg DM, respectively). For Jerseys, hepatic Fe was greater for cows receiving supplemental Fe (254 µg/g DM) compared to controls (184 µg/g DM). Hepatic Zn did not differ for breeds or Fe supplementation. Plasma Cu was greater for Jerseys (0.72 µg/ml) compared to Holsteins (0.61 µg/ml). Plasma Zn and Fe did not differ for breeds or Fe supplementation. Iron supplementation did not affect milk yield or milk fat percentage. Milk protein percentage was greater for cows receiving supplemental Fe. Dietary Fe did not affect Cu status or productivity of Holstein and Jersey cows in this experiment.

Key Words: Copper, Holstein, Jersey

1272 Effect of feeding complexed zinc methionine, manganese methionine, copper lysine, and cobalt glucoheptonate on lactational and reproductive performances by lactating Holstein cows. P. Mandevu*¹, K. C. Uchida², C. J. Sniffen¹, C. S. Ballard¹, and M. P. Carter¹, ¹*W. H. Miner Agricultural Research Institute, Chazy, NY*, ²*Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan.*

This study was undertaken to determine the effect of feeding chelated trace minerals on performance of Holstein cows. The product used as a source of the chelated minerals was called Availa4[®] (Zinpro Corp., Eden Prairie, MN). Pregnant cows (n=40) were blocked by parity, previous milk production and predicted calving date, and randomly assigned to treatments at calving. After 48±30 d cows were moved within treatment, from the fresh group (FG) to the high producing (HP) group. Cows were housed in a free-stall barn and group-fed total mixed rations (TMR) containing inorganic minerals (control) or inorganic minerals

and Availa4[®] (Availa4) for ad libitum intake. Cows were kept on the study for a minimum of 80 d or until first breeding service. The TMR were formulated using the CPM Dairy[®] model to exceed NRC (1988) trace mineral requirements for lactating dairy cows. The TMR consisted of approximately 51% forage and 49% concentrate (DM basis) for both the FG and HP cows. The Availa4 TMR was formulated to supply each cow with 7 g of Availa4[®] (DM basis) daily by partially substituting the inorganic minerals in the concentrate mix. Each 7 g of Availa4[®] supplied 360 mg of zinc (Zn), 200 mg of manganese (Mn), 125 mg of copper (Cu), and 12 mg of cobalt (Co). The control TMR was formulated to supply each cow with an equivalent amount of additional Zn, Mn, Cu, and Co from inorganic sources. The control and Availa4 TMR had similar concentrations of CP: 17.5% for FG cows and 18.0% for HP cows, and NDF: 32.8% for FG cows and 32.2% for HP cows. The performance by cows fed the control TMR and Availa4 TMR, respectively were milk yield kg/d (wk 1-8): 44.9 and 44.4 (SE=0.44); milk fat % (wk 1-8): 4.05 and 4.23 (SE=0.062); milk crude protein % (wk 1-8): 3.18 and 3.25 (SE=0.19); linear somatic cell count (wk 1-8): 4.10 and 3.74 (SE=0.079); services per conception: 2.04 and 1.58 (SE=0.23); and days to conception: 101 and 77 (SE=11.45). Days to conception were lower for Availa4 cows ($P < 0.002$). Conception rate at 150 days postpartum for the control cows was 61.1% while the Availa4 cows was 95.0%. Feeding Availa4[®] to lactating Holstein cows improved conception rate with fewer days open but had no significant effect on milk production, milk fat and protein content, linear somatic cell count, body condition score and lameness score.

Key Words: Key words: Dairy cow, Availa4[®], Milk production, Reproductive performance

1273 Zinc-methionine improves udder health and Zn metabolism in lactating dairy goats. A. Salama, G. Caja*, E. Albanell, X. Such, R. Casals, and R. Parés, *Universitat Autònoma de Barcelona, Bellaterra, Spain.*

Lactation and metabolism trials were conducted to investigate the effects of supplementation with Zn-Methionine (Zn-Met) on milk yield, milk composition, milk SCC, udder health, N and Zn metabolism in 22 Murciano-Granadina dairy goats milked once-a-day from week 2 to 20 of lactation. Each half udder was studied separately. Goats were fed a diet based on a dehydrated mixture of maize-whole plant and alfalfa *ad libitum*, alfalfa pellets, barley grain and concentrate mixture. Treatments were: Control (C) and supplemented (S) with 1g/d Zn-Met (Biomet-10[®], Norel SA, Madrid, Spain). For the S group, Zn-Met was included in the concentrate mixture. Average milk yield was not affected by Zn-Met supplementation (2.04 l/d; $P > 0.05$), but percentage of milk fat tended to be lower (C: 5.12%; S: 4.67%; $P < 0.06$). Percentages of total protein, true protein and casein were not significantly affected by treatments. Lower values ($P < 0.05$) of milk whey protein (0.56 vs. 0.62 %) and milk NPN (0.29 vs. 0.34 %) were observed in S vs. C group. The geometric mean of milk SCC decreased by 24% as a result of supplementation (C: 333×10^3 ; S: 269×10^3 ; $P < 0.11$) but C values were reduced to 293×10^3 and differences were not significant ($P > 0.05$) when halves with persistent infection were excluded from the analysis. Infection prevalence was 14% for C group vs. 5% for S group ($P < 0.05$). For the metabolism trial, apparent absorption of N ($P < 0.01$) and Zn ($P < 0.12$) increased for the S goats, which also tended to retain more Zn than goats of the C group (52.5 vs. 21.4 mg/d; $P < 0.08$). We conclude that Zn-Met supplementation seems to play a positive role on mastitis resistance. The N and Zn utilization in the whole animal body was also improved when Zn-Met was fed.

Key Words: Zinc Chelates, Somatic Cell Counts, Zn Metabolism

1274 Comparison of the blood and urine acidifying activity of common dietary chloride and sulfate supplements. J.P. Goff* and R.L. Horst, *USDA-Agricultural Research Service, Ames, IA.*

Evidence suggests calcium homeostasis in the periparturient cow is impaired by metabolic alkalosis; common in cows fed diets high in cations such as potassium. When decreasing dietary potassium is insufficient to control hypocalcemia, anions are added to the diet to induce a mild

metabolic acidosis to reduce periparturient hypocalcemia and milk fever. Chloride and sulfate are commonly used for this purpose, though there may be differences in the blood acidifying activity of these anions. In each of the following trials 7 non-preg, non-lact Jersey cows received 7 treatments during one of 7 five day treatment periods in a crossover design. Treatment periods were separated by 5 days of feeding the basal alfalfa diet alone. Basal diet was limit fed (2X/d) to insure that all added anions were consumed. Treatments consisted of 0.75, 1.5, or 2.25 Eq/d of either a chloride or sulfate anion source dissolved in water, or water alone, added to the basal diet. Three trials were run to compare the effects of hydrochloric acid vs. sulfuric acid, Ca chloride vs. Ca sulfate, and Mg chloride vs. Mg sulfate. Three hr after the last feeding on day 5 of each treatment period, blood and mid-stream urine samples were obtained. Urine pH, and blood pH and standard base excess (SBE) were determined and plotted against the dose of each anion utilized. The slope of the regression line obtained for the anion sources in each trial were determined. Urine pH decreased as addition of anions to the diet increased, but there was no significant difference in the slopes of the lines determined for the different anion sources. Blood pH and SBE were negatively correlated with the dose of hydrochloric acid, Ca chloride, Mg chloride, and Ca sulfate. However blood pH and SBE were not significantly correlated with sulfuric acid or Mg sulfate dose, suggesting a weak effect of these anion sources on blood acidity. The slopes of the lines describing the effect of Ca chloride on SBE and blood pH were 1.7 and 1.6 fold greater respectively than the slopes describing the effect of Ca sulfate on SBE and blood pH. Chloride consistently decreased blood acidity more than the sulfate anions suggesting that chloride sources would be more effective for prevention of hypocalcemia in periparturient cows than sulfate sources.

Key Words: Anion, Milk fever, Metabolic Acidosis

1275 Direct fed microbial and anionic salt supplementation to dairy cows fed 21 days pre- to 70 days postpartum. E. Block¹, J.E. Nocek², W.P. Kautz^{*3}, and J.A.Z. Leedle³, ¹McGill University, ²Spruce Haven Farm and Research Ctr, ³Chr. Hansen BioSystems.

Sixty-four multiparous Holstein cows were used to evaluate the effect of anionic salts in combination with a direct fed microbial (DFM)/yeast(Y) in the prepartum period and DFM/Y on production performance during the postpartum period. Four close-up dry diets were fed to 4 groups of 16 cows each starting at 21-days precalving as follows: a) no anionic salts, no DFM/Y, b) anionic salts, no DFM/Y, c) no anionic salts, DFM/Y at 90g/d, and d) anionic salts, DFM/Y at 90g/d. After calving, eight cows from each prepartum group were fed a lactation ration with or without DFM/Y supplementation top dressed at rate 90g/d. The 90g of DFM contained approximately 5×10^9 CFU yeast and 5×10^9 CFU bacteria (*Lactobacillus plantarum*/*Enterococcus faecium*). There were no significant effects of prepartum treatments on prepartum DMI or postpartum DMI or milk production; therefore, postpartum performance data were pooled for cows which did or did not receive DFM/Y supplementation. DMI, milk yield, and milk protein were higher for cows receiving DFM/Y supplementation ($P < .05$). Blood glucose and insulin were higher and NEFA lower for cows receiving DFM/Y in the lactation period ($P < .05$). These data suggest that DFM/Y supplementation resulted in increased DMI and milk production. Blood metabolic indices suggest more glucose was made available with less fatty acid mobilization from lipid stores with DFM/Y supplementation.

Period	Trt	DMI (kg/d)	Milk (kg/d)	Protein (%)	Glucose (mg/dl)	Insulin (uIU/ml)	NEFA (uM/L)
1 to 7d	Control	12.9 ^b	22.1 ^b	3.98	51.1 ^b	8.9 ^b	598
	DFM/Y	15.3 ^a	22.4 ^a	4.01	59.3 ^a	12.2 ^a	488
8 to 21d	Control	18.4 ^b	34.5 ^b	3.21 ^b	49.7 ^b	10.6 ^b	624 ^d
	DFM/Y	21.2 ^a	36.1 ^a	3.35 ^a	55.7 ^a	16.8 ^a	570 ^c
22 to 70d	Control	24.6 ^d	48.2 ^d	3.01 ^b	52.1 ^b	23.7	658 ^b
	DFM/Y	25.1 ^c	49.1 ^c	3.27 ^a	58.1 ^a	24.7	525 ^a

^{a,b} means in the same column within time differ $P < .05$ ^{c,d} means in the same column within time differ $P < .10$

Key Words: DFM, Anionic salt, Production

SHEEP SPECIES

1276 Comparison of three measuring techniques for staple length and strength in U.S. wools. F. A. Pfeiffer* and C. J. Lupton, *Texas Agricultural Experiment Station, San Angelo.*

Consignments (29) of greasy wool in Texas warehouses were used to compare three measuring techniques each for staple length (SL) and strength (SS) of greasy wool and to assist the U.S. wool industry in deciding which techniques to adopt. Samples (~4.5 kg/lot) were obtained using a bale grab sampler and were subsampled at the Wool and Mohair Research Lab (WMRL) to provide three sets of comparable staples. One complete set of staples (29 lots x 65 staples = 1,885 staples) was sent to the Australian Wool Testing Authority (AWTA) for measurement using the Automatic Tester for Length and Strength. Another set was sent to SGS Wool Testing Services (SGS) in New Zealand for testing with the Agritest Staple Breaker Model 2. A third set was measured at WMRL using an American Society for Testing and Materials manual method for SL and an Agritest Staple Breaker (manual model) for SS. Each testing lab used the same wool base and vegetable matter base values to convert "greasy" to "clean" SS. Paired t tests and linear regression were used to test for differences and calculate r^2 values between test methods. Warehouse personnel provided visual estimates of SL. Mean values of SL determined by AWTA and the visual assessments were not different (8.14 and 8.16 cm, respectively, $P > .05$; $r^2 = .63$). Measurements of SL made by SGS and WMRL were not different (7.80 and 7.92 cm, respectively, $P > .05$; $r^2 = .74$), but were smaller ($P < .05$) than the AWTA and visual results. Mean values of variability in staple length (CV) were not different ($P > .05$) among measuring techniques. The AWTA and SGS means of SS were not different (32.1 and 31.8 N/ktex, respectively, $P > .05$; $r^2 = .41$). The WMRL mean value 41.7 N/ktex for SS was greater ($P < .05$) than the other two labs, strongly suggesting that either the manual instrument and/or the WMRL technique produced excessively high values. Further testing incorporating a broader cross-section of U.S. wools is required before a recommendation can be made to the U.S. wool trade.

Key Words: Wool, Staple length, Staple strength

1277 Carcass composition and sensory characteristics of barbacoa from New Zealand imported and Mexican Pelibuey lambs. N. Torres, J. Gutierrez, M. S. Rubio, and R. D. Mendez*, *Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autonoma de Mexico, Mexico.*

This research was designed to determine differences in the carcass composition and sensory characteristics of three commercial types of lambs in Mexico. Twenty-eight carcasses, 10 Pelibuey (P), 8 crosses of P and Suffolk (PS), and 10 New Zealand imported carcass (I), were selected based on their commercial weight (15 kg). Dissection of primary cuts (neck, shoulder, leg, rack, skirt, loin, and shank) was used to determine carcass composition (muscle, fat, bone, and "other" tissues which includes cartilage, nerves, etc). Traditional Mexican "barbacoa" was cooked by one expert and under identical conditions for the three types of lamb. A consumer sensory panel of 160 people was used to determine aroma and flavor on the "barbacoa" samples. Carcass composition data and sensory parameters were analyzed using type of breed as the independent variable in the analysis of variance. Results from the carcass composition analyses showed that national and imported lamb had no differences in the muscle percentage. However, P lambs (19.31±2.42%) had lower ($P < .05$) bone percentage than lambs from the PS or I (21.91±2.41% and 20.96±1.50%, respectively). Even though total fat percentage was not different among lambs, P animals had more ($P < .05$) intermuscular (9.90±3.13) and internal (1.63±0.83) fat than those from I (8.02±3.26; 0.90±0.28) or PS (6.28±3.23; 1.44±0.59). On the other hand, other tissues were found in higher proportions ($P < .05$) on imported animals (11.38±1.66%) compared to national ones PS and P (10.62±2.55% and 9.03±1.98%, respectively). Consumers found no differences in the aroma or flavor from the three types of "barbacoa". Therefore, these data do not support the Mexican producers position, to base the price of their national lamb on the belief that they have a better yield and a better taste compared to the imported ones.

Key Words: Pelibuey, Meat, Carcass composition

1278 Effects of pen, fleece coats, and breed on growth, meat, and wool traits of feeder lambs. C. J. Lupton*¹, J. E. Huston¹, B. F. Craddock², J. W. Jennings³, and F. A. Pfeiffer¹, ¹Texas Agricultural Experiment Station, ²Texas Agricultural Extension Service, ³Angelo State University, San Angelo, TX.

Anticipated new marketing channels may permit greater emphasis on wool from slaughter lambs producing heavier, but leaner carcasses. Following a 3-wk uniformity period, 34 each of Rambouillet (R) and Merino x R (MR) unshorn wether lambs (~4 mo of age, BW = 33.7 ± 4.3 kg) were assigned equally to two treatment groups (blocked by initial BW and breed) to evaluate the effects of pen (area and number of animals per pen), breed, and fleece coat on growth, carcass, and wool traits. The two treatments consisted of lambs maintained in small (SP; 2 or 3 lambs / 15 m²) and large (LP; 35 lambs / 930 m²) pens. The lambs received conventional, step-up feedlot rations to produce an ADG of .21 ± .04 kg/d and were shorn on d 134, slaughtered on d 136, with carcass evaluation on d 137. The effects of pen on ADG, final shorn BW (55.6 ± 7.0 kg), warm carcass weight (30.3 ± 4.2 kg), dressing percentage (54.4 ± 1.9), back fat thickness (12th rib; 8.4 ± 2.5 mm), leg circumference (69.0 ± 3.0 cm), carcass length (111.4 ± 4.3 cm), USDA yield grade (2.63 ± .75), calculated yield grade (3.71 ± 1.01), fleece weight (3.83 ± .81 kg), staple length (7.58 ± 1.01 cm), and fiber diameter (21.5 ± 1.9 μm) were not significant ($P > .09$). Body wall thickness of LP > SP lambs (3.8 vs. 3.5 cm, $P = .02$). Coated lambs produced lighter fleeces (3.5 vs. 4.0 kg, $P = .007$) presumably due to less contamination. No other effects of coat were significant ($P > .07$). These results indicate that data collected on coated and uncoated lambs in small scale feeding trials (sometimes necessary for economical reasons and measurement of feed efficiency, for example) can be extrapolated with confidence to larger scale feeding situations. In contrast, most effects of breed were significant ($P < .06$; fat thickness and calculated yield grade being exceptions) with R > MR for growth and carcass traits and < MR for wool traits, confirming that fine-wool lambs of different breeding can be expected to perform differently in the feedlot.

Key Words: Lamb feeding, Carcass traits, Wool traits

1279 Utilizing real-time ultrasound to predict carcass quality of lambs. R. R. Panting*¹, S. N. Harrison¹, J. C. Jensen², S. Nash¹, J. H. Packham¹, D. Whittier², and S. K. Duckett¹, ¹University of Idaho, Moscow, ²Utah State University, Logan.

Real-time ultrasound technology has been successfully used to estimate carcass quality and predict retail yield in finished beef cattle; however, limited research is available on using this technology on finished lambs. The objectives of this study were to: 1) determine the accuracy and repeatability of real-time ultrasound measures of fat thickness (FT) and ribeye area (REA) to carcass measures for seven technicians, and 2) to develop equations for predicting the retail product weight from real-time ultrasound measures of FT and REA. Twenty-four lambs were weighed and scanned twice by seven ultrasound technicians in a blind trial to obtain FT and REA measures. Ultrasound measurements for FT and REA were compared to carcass measures. Standard error of prediction for REA and FT for the seven technicians ranged from 1.74 to 2.69 cm² and .084 to .137 cm, respectively. Standard error of repeatability for REA and FT for the seven technicians ranged from 1.07 to 3.25 cm² and .079 to .16 cm, respectively. Seventy-one lambs were weighed and scanned by two ultrasound technicians prior to harvest. After harvest, carcass measures and retail product weight (IMPS 207, 233A, 1204B, 1232A, all trimmed to .64 cm or less external fat cover) were obtained for all lamb carcasses. For the 71 lambs, standard error of predictions for real-time ultrasound measures of FT and REA compared to carcass measures were .16 cm and 2.32 cm², respectively. Correlation coefficients for retail product weight with live weight, ultrasound REA, carcass REA, ultrasound FT, and carcass FT were .88, .82, .70, .36, and .52, respectively. Regression equations were developed using the stepwise procedure of SAS to predict retail product (kg) from all carcass and ultrasound measures. The prediction equation developed was: retail product, kg = -1.152 + .196 x liveweight (kg) + .367 x real-time ultrasound REA (cm²) and explained 86% of the variation in retail product weight ($P = .01$; SE $P = .90$). No carcass measures met the significance level ($P = .15$) for entry into the model to predict retail product. Thus, real-time ultrasound technology can be utilized to estimate carcass quality and retail product in lamb as well as in beef.

Key Words: Lamb, Ultrasound, Carcass

1280 Body weight, fleece weight, and wool characteristics of Texel x Romney crossbred yearling sheep. T Wuliji*¹ and K.G Dodds², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, ²AgResearch, Invermay Agricultural Centre, Mosgiel, New Zealand.

Live weight, fleece weight, and wool characteristics of yearling sheep were analyzed for control Romney (CR), Romney selected for high fleece weight (HR), Texel x Romney (TR_{F1}), Texel x Romney intercross (TR_{F2}), Texel x [Texel x Romney] (TTR), [Texel x Romney] x Romney (TRR), and [Poll Dorset x Romney] x [Texel x Romney] (DTR). Birth rearing rank, birth weight (BRW), weaning weight (WW), spring weight (SW), and greasy fleece weight (GF) were recorded. Wool samples were measured for oven dry yield (%), bulk, fiber diameter, wool brightness (Y), and yellowness (Y-Z). Data were analyzed by residual maximum likelihood (REML), with genotype, year, sex, birth rearing rank, and age of dam included as fixed effects, birth date as a covariate, and sire as a random effect. Crossbred genotypes had 13 to 23% higher fleece weight than CR ($P < .05$), but fleece weights were lower than for HR ($P < .05$). Wool bulk was increased by 22 to 37% and wool fibre diameter was reduced by about 1.5 μm in most crossbred genotypes compared with Romneys. Table 1. Genotype least squares means for live weight, fleece weight, and wool characteristics (^{a,b,c,d}Means with different superscripts differ, $P < .05$).

Geno- type ¹	BRW (kg)	WW (kg)	SW (kg)	GF (kg)	Yield (%)	Bulk (cm ³ /g)	FD (micron)	Y-Z
CR	4.3 ^a	21.5 ^a	45.2 ^a	2.31 ^b	65.6 ^d	23.7 ^a	32.5 ^{bc}	4.8
HR	4.5 ^{ab}	25.0 ^{cd}	50.2 ^b	3.26 ^e	64.7 ^{cd}	25.7 ^b	34.0 ^c	4.8
TRR	4.9 ^{cd}	23.2 ^b	50.8 ^b	2.85 ^d	62.6 ^b	26.4 ^b	32.6 ^b	4.9
TR _{F1}	5.0 ^d	25.8 ^d	53.6 ^c	2.66 ^c	63.7 ^{bc}	29.1 ^c	32.5 ^b	5.1
TR _{F2}	4.7 ^{bcd}	25.9 ^d	54.2 ^c	2.71 ^{cd}	60.9 ^a	30.0 ^c	32.6 ^{abc}	5.1
DTR	4.6 ^{abc}	26.1 ^d	55.3 ^c	2.62 ^c	62.7 ^b	32.5 ^d	32.5 ^{ab}	4.4
TTR	4.5 ^{ab}	24.1 ^{bc}	48.9 ^b	2.06 ^a	63.3 ^{abc}	29.0 ^c	30.8 ^a	5.1
SED	.2	.6	1.5	.10	.9	.6	.7	.3

¹Number of animals for CR, HR, TRR, TR_{F1}, TR_{F2}, DTR, and TTR were 181, 136, 470, 233, 84, 90, and 55, respectively.

Key Words: Texel, Romney, Wool

1281 Effects of sex, birth rearing, and age of dam on yearling crossbred progeny of Texel x Romney sheep. T Wuliji*¹ and K.G Dodds², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, OK, ²AgResearch Invermay Agricultural Research Center, Mosgiel, New Zealand.

A total of 1,259 progeny from groups of Romney, Texel x Romney, and Texel x Romney intercross were analyzed. Birth rearing rank, birth weight (BRW), weaning weight (WW), spring weight (SW), greasy fleece weight (GF), oven dry yield (%), fiber diameter, bulk, wool brightness (Y), and yellowness (Y-Z) were measured. Data were analyzed by residual maximum likelihood (REML). Genotype, year, sex, birth rearing rank, and age of dam were included as fixed effects, birth day as a covariate, and sire as a random effect. Males were heavier, and grew more yellow and bulkier wool ($P < .01$) than females. Single born and reared animals were heavier ($P < .05$) than twin born animals, with twins that were single reared being heavier ($P < .05$) at weaning than those that were twin reared. Birth rearing rank did not affect wool characteristics, except for yield where twin born and reared animals were greater ($P < .05$) than the other rearing types. Age of dam had no effect on wool characteristics, but 2 yr-old dams had slightly lower birth and weaning weight than older dams. Table 1. Effects of sex, birth rearing, and age of dam on production parameters

	Sex ¹			Birth rearing rank			Age of Dam ²			
	Ewe	Ram	SED	SS	TS	TT	SED	2	3	4+
BW	4.5	4.8	.04	5.5 ^b	4.2 ^{ab}	4.2 ^a	.07	4.3	4.8	4.9
WW	23.8	25.2	.62	27.4 ^c	24.3 ^b	21.8 ^a	.31	23.5 ^a	25.2 ^b	24.9 ^b
SW	47.5	54.8	.37	52.9 ^b	50.5 ^a	50.1 ^a	.54	50.1 ^a	51.4 ^a	52.0 ^b
GF	2.54	2.74	.03	2.67	2.62	2.63	.04	2.61	2.67	2.64
Yield	64.4	62.4	.27	63.0 ^a	63.0 ^{ab}	63.8 ^b	.38	63.0 ^a	63.8 ^b	63.3 ^a
Bulk	31.7	32.2	.20	31.8	32.3	31.8	.29	32.1 ^b	31.6 ^a	32.1 ^b
FD	32.5	32.6	.18	32.5	32.4	32.7	.70	32.6	32.5	32.5
Y	65.3	64.0	.14	64.7	64.7	64.3	.19	64.5	64.5	64.7
Y-Z	4.6	5.1	.08	4.9	4.8	4.9	.10	4.8	4.9	4.9

¹All traits differed between sexes, $P < .01$; means within rows with a different superscript in the trait columns differ, $P < .05$; SS: single born and reared; TS: twin born and single reared; TT: twin born and reared.

²SED for BW, WW, SW, CF, Yield, Bulk, FD, Y, and Y-Z were .06, .30, .51, .04, .34, .24, .24, .17, and .10 g, respectively.

Key Words: Crossbred, Sheep, Rearing rank

1282 The economics of hair sheep production in the US Virgin Islands. R.W. Godfrey*¹ and G. D'Souza², ¹Agricultural Experiment Station, University of the Virgin Islands, ²College of Agricultural, Forestry and Consumer Sciences, West Virginia University, Morgantown.

Production of small ruminants in the US Virgin Islands (USVI) is the only option available to many livestock farmers due to limited land and resources. The use of hair sheep in the tropics is ideal because they are well adapted to the climate. Based on 14 yr of production data, establishment and annual maintenance budgets for hair sheep production in the USVI has been developed. Budgets were developed for two flock sizes: small (100 head; 24.3 ha) and large (350 head; 70.8 ha). Assumptions made when developing the budgets included locating the farm in an area of average rainfall, use of limited breeding and lambing seasons, an average lamb crop of 1.8 lambs per ewe lambing, a 10% lamb death loss, a replacement rate of 10% annually, a stocking rate of 8.6 ewes per ha, a local market price of \$3.30 per kg for lambs and \$4.96 per kg for breeding stock, and the producer already owns the land and has access to a water supply. The establishment budget for the small flock came to a total of \$39,180 with major categories of expense being the fencing (\$18,490) and purchase of animals (\$12,375). The maintenance budget for the small flock yielded total operating costs of \$11,532 with a revenue of \$16,009 and a pre-tax return of \$1,223 and a breakeven price of \$3.11/kg. The establishment budget for the large flock came to a total of \$101,388. The highest costs were fencing (\$38,850) and animals (\$43,313). The large flock can generate revenue of \$56,509 annually with operating costs of \$27,546. The pre-tax returns would be \$21,024 for the large flock with a break-even price of \$2.05 per kg. The benefits of the larger sheep flock appear to be due to an economy of scale. The estimated net present value of the large flock, assuming a 20-yr planning horizon and a 10% cost of capital is \$77,602, and the estimated internal rate of return is 20%. Even though both operations can be profitable, it appears that the larger operation would be more feasible in the long run.

Key Words: Sheep, Economics, Tropics

1283 Parasite burdens of purebred and crossbred hair lambs during the wet season in a tropical environment. R.W. Godfrey*, R.E. Dodson, and E. Panitz, Agricultural Experiment Station, University of the Virgin Islands, St. Croix.

Parasite burden and packed cell volume (PCV) were evaluated in St. Croix White (n = 11) and Barbados Blackbelly (n = 16) lambs (HAIR) and 1/4 Suffolk X 3/4 St Croix White (n = 14; WXH) lambs on pasture in September. Lambs were kept in drylot for 2 wk after weaning (66 ± 3 d of age) and then put in a .5 ha guineagrass pasture. Anthelmintic was given 14 to 28 d prior to grazing and then at 42-d intervals. Fecal samples were collected weekly for 147 d to determine parasite burden as eggs/g (COUNT) using the modified McMaster technique. Species evaluated were *Moniezia expansa* (MON), trichostrongylid ova (TRIC), and coccidia (COC). Prior to analysis, data were transformed using log₁₀(COUNT + 1). On the days of fecal collection, a jugular blood sample was collected to determine PCV and lambs were weighed. Data were analyzed using SAS procedures for repeated measures and lamb mortality rate was analyzed using the CATMOD procedure. Crossbred lambs were heavier than HAIR lambs during the 147-d grazing period ($P < .001$). The HAIR lambs had higher PCV ($P < .0001$) than WXH lambs following the second anthelmintic treatment. There was no difference ($P > .10$) in COC or MON counts between HAIR and WXH lambs. The WXH lambs had higher ($P < .06$) TRIC counts after the second anthelmintic treatment. The mortality rate of WXH lambs was higher ($P < .06$) than that of the HAIR lambs during the first 63 d of the grazing period (57.1 vs 33.3%, respectively). At the end of the 147-d period there was no difference in lamb mortality between WXH and HAIR lambs (57.1 vs 48.1%, respectively) which may be related to stress due to a hurricane which impacted the island at that time (d 70). Packed cell volume was positively correlated ($P < .002$) with body weight and COC in the WXH lambs, but not in HAIR lambs. These data show that purebred hair lambs have lower total parasite burdens than WXH lambs in the tropics. The high mortality rate of the WXH

lambs during the rainy season is most likely due to the higher parasite burden.

Key Words: Sheep, Parasites, Environment

1284 Fiber analysis of wool and hair crossbred sheep. R.W. Godfrey^{*1}, J.K. Bultman¹, and C.J. Lupton², ¹Agricultural Experiment Station, University of the Virgin Islands, St Croix, ²Texas Agricultural Experiment Station, San Angelo.

The prolificacy, parasite tolerance, and out of season breeding of hair sheep are desirable traits that can be selected for when crossing these sheep with wool breeds. The lack of any substantial fleece on the hair sheep is also a desirable trait in some circumstances. Fleeces (12) of wool X hair crossbred sheep were evaluated to compare traits among genotypes. Two Suffolk X St Croix White rams (SFK1), four Polypay X St Croix White rams (PPY), and six 1/4 Suffolk X 3/4 St Croix White lambs (SFK2) were shorn and their fleeces evaluated. The SFK1 rams were the sires of the SFK2 lambs, although exact paternity is unknown. The ages at shearing were 801, 381, and 156 d for SFK1, PPY, and SFK2, respectively. Traits evaluated for each fleece were fiber diameter (μm , DIAM), and percentages of total medullated fibers (MED), flat fibers (FLAT), objectionable fibers (OBJ), and clean yield (Y). The SFK1 and PPY rams had the phenotype of wool sheep, but SFK2 lambs had more variation in phenotype with some lambs appearing to have full wool fleeces and others having mostly hair. The SFK2 lambs, even though they were much younger, had higher percentages of medullated, flat, and objectionable fibers in their fleeces than either the SFK1 or PPY rams. Even with the low number of animals, the variation in the phenotype of the fleece on SFK2 lambs indicates that it would be possible to select for fleece type in crossbred (wool X hair) sheep.

Breed	DIAM	MED	FLAT	OBJ	Y
SFK1	33.3 \pm .6	.73 \pm .05	.02 \pm .02	.24 \pm .09	82.9 \pm 2.3
PPY	24.4 \pm 1.4	1.13 \pm .35	.05 \pm .01	.23 \pm .08	72.9 \pm 1.6
SFK2	27.5 \pm 1.1	7.93 \pm 1.53	.37 \pm .13	4.3 \pm 1.2	87.3 \pm 1.3

Key Words: Sheep, Wool, Hair

1285 Carcass characteristics and commercial cuts of Suffolk lambs at creep feeding management system. A.L.G. Monteiro¹, M. A. Neres^{1,2}, C. A. Garcia¹, G.J.M. Rosa^{*2}, and C. Costa², ¹Animal Production Dept., UNIMAR, SP, Brazil, ²Animal Nutrition Dept., UNESP, SP, Brazil.

Twenty-four single ewe Suffolk lambs were randomly assigned at birth to three treatment groups so that four males and four females were included in each one. All lambs were fed concentrate creep (21% Crude Protein) with alfalfa hay (0, 15, and 30%: treatments 1, 2, and 3, respectively) plus maize, soybean meal, and mineral salt, and were allowed to nurse their mothers. The ewes were fed with lactation concentrate and Tifton hay. All animals were grazed in *Cynodon nlemfuensis* plots until weaning (60 d), when all lambs were fed the same diet in drylot. The lambs were slaughtered when they reached 30 kg liveweight. The following measurements were taken: liveweight slaughter, ingesta-free body weight, hot and cold carcass weight, hot, cold, and true dressing-out percentages, and cooling loss. After a 24 h carcass chill, they were sectioned and the left sides were divided in five anatomical cuts: leg, shoulder, loin, racks, and neck. Cuts were weighed and their percentages were determined. It was observed that different levels of alfalfa hay in ration did not significantly affect ingesta-free body weight ($P=0.27$), hot ($P=0.24$) and cold ($P=0.22$) carcass weights, and cooling loss ($P=0.49$). Therefore, lambs fed with 15% alfalfa hay at creep ration presented higher ($P<0.05$) dressing-out percentages compared to the others. In respect to cuts, just shoulder and neck weights were influenced ($P<0.05$) by treatments, but not in a uniform trend. Cut percentages were not significantly ($P>0.05$) affected. The most important commercial cuts, loin and legs, were not significantly related to different treatments. These cuts presented average weights of 0.8 and 2.7 kg, respectively, which could be accepted commercially. It was concluded that different contents of alfalfa hay at creep ration may influence dressing-out percentages and that, although 15% presented the best results, the three levels could be recommended to lamb creep rations.

Key Words: Sheep, Dressing percentages, Cuts

1286 The effects of concentrate and soybean meal level for pregnant ewes offered grass silage on ewe and lamb performance. T.F. Crosby^{*1}, P. Nowakowski², J.V. O'Doherty¹, P.J. Quinn¹, J.J. Callan¹, B. Flynn¹, D. Cunningham¹, P. Reilly¹, and W. Byrne¹, ¹University College Dublin, Lyons Research Farm, Newcastle, Co. Dublin, Ireland, ²Agricultural University Wroclaw, Dept. of Sheep Breeding, Wroclaw, Poland.

The objective was to examine the effects of supplementing a grass silage based diet with varying levels of concentrates and soybean meal on the performance of pregnant ewes and their lambs, and on colostrum yield and quality. Twin bearing pregnant ewes ($n=63$) were individually penned and allocated to a 3 x 3 factorial experiment and offered grass silage ad libitum supplemented with three levels (0 g, 200 g, 400 g) of a barley/molassed sugar beet pulp based concentrate and three levels (50 g, 100 g, 150 g) of soybean meal per ewe/d from d 98 of pregnancy until lambing. As concentrate or soybean levels increased, there was no effect on silage dry matter (DM) intake, but total DM, metabolizable energy, and crude protein intakes did increase ($P<0.05$). Mean ewe live weight loss across all treatments from d 98 of pregnancy to 24 h postpartum ranged from 1.4 kg to 11.8 kg. The magnitude of the loss was negatively related to both the levels of concentrates and soybean ($P<0.05$). Ewe colostrum yields at 1 h, 10 h and 18 h post lambing were all increased as the concentrate level increased, resulting in the increased yield at 18 h (1346 v 1785 v 2142 ml; SEM 143: $P<0.05$) being almost linear. As soybean level increased, there was an increase in colostrum yield at all milkings, the difference reaching significance ($P<0.05$) at the 1 h milking and in total yield at 18 h. At the zero concentrate and at the 50 g soybean levels, the 1 h colostrum immunoglobulin yield (IgG) was lowest ($P<0.05$). When no concentrates were fed, lamb weight was lowered at three wk ($P<0.05$), but not at later stages up to weaning. These data quantify the need for adequate concentrate and protein supplementation in order to prevent excessive ewe weight loss, for adequate yields of colostrum with high immunoglobulin yields, and for high lamb growth rate to 3 wk of age.

Key Words: Ewe, Protein, Colostrum

1287 An evaluation of some by-product feeds as the sole diet for early-weaned lambs. T.F. Crosby^{*1}, P.J. Quinn¹, J.J. Callan¹, B. Flynn¹, P. Nowakowski², J.V. O'Doherty¹, and J.P. Day¹, ¹University College Dublin, Lyons Research Farm, Newcastle, Co. Dublin, Ireland, ²Agricultural University Wroclaw, Dept. of Sheep Breeding, Kozuchowska, 7, 51-631, Wroclaw, Poland.

Feed is the single biggest production cost factor in lamb systems based on early weaning. In Europe, there is wide variation in the cost of available feed ingredients, with by-product feeds being at the lower end and commercial concentrate mixtures being at the upper end. The present experiment was undertaken to examine the possibility of using a mixture of by-product feeds as the sole diet for the early weaned lamb on lamb growth rate, feed efficiency, carcass quality, and economic returns. Texel sired lambs ($n=108$) were weaned when 37 d old and allocated to dietary treatments based either on a mixture of molassed sugar beet pulp/corn gluten/distillers grain (T1) or an expensive high specification commercial concentrate (T2). Both diets were offered ad libitum. From birth to slaughter, T1 lambs had a higher concentrate intake (116.1 v 83.2 kg) and a poorer food conversion efficiency (5.05 v 3.58:1) which was partly due to ingredient selection by the lambs and unavoidable wastage, especially of distillers grains. Lamb growth rate from birth to slaughter was lower in T1 (330 v 302 g/d, SEM 5.7; $P<0.05$) with male lambs having a higher ($P<0.05$) growth rate than female lambs. Lambs in T1 were lighter at 82 d of age (28.0 v 30.2 kg, SEM 0.74; $P<0.05$) and took 9.9 d longer to reach slaughter weight (117.2 v 107.3 d, SEM 2.0; $P<0.05$). Although there was no difference in live weight at slaughter, lambs in T1 yielded lighter carcasses (18.59 v 19.21 kg, SEM 0.179; $P<0.05$), with a lighter fat covering and a more desirable fat consistency ($P<0.05$). The lambs in T1 realised US\$3.80 less, which was a reflection of a lower kill out proportion and a later sale date; this loss was offset by lower feed costs. The data show that very acceptable growth rates and carcasses can be obtained with cheap by-product feeds, but there is the need to reduce ingredient separation and minimise refusals of single ingredients.

Key Words: Lamb, By-product, Growth

1288 Fertility and lambing performance of Katahdin hair sheep under an accelerated breeding system. S. Wildeus* and J. R. Collins, *Virginia State University, Petersburg.*

This study evaluated ewe performance in a flock of Katahdin hair sheep (n=25) managed under an 8-mo breeding schedule. Animals were grazed on moderate quality, permanent pastures or provided hay depending on time of year, and grain mix (16% CP) was supplemented according to stage of production. Ewes were mated in single-sire mating groups during 42-d breeding seasons, starting the first of November, July, and March, respectively. Breeding rams passed a soundness examination and were fitted with marking harnesses for breeding. Conception rate was determined by transrectal ultrasonography on d 1 and 20 after the end of breeding. Ewes lambed unassisted on pasture and lambs were weaned at 9 wk of age. Data were analyzed in a model with season as main effect. Conception rates were similar for all breeding seasons (mean 88%), however, lambing rate was lower (P<.05) for July breeding (65%). Time to mating from onset of breeding was later (P<.01) for July (25.3 d) than for November and March breeding (9.1 and 14.1 d, respectively). Litter size was larger (P<.05) following July (1.67) than November (1.27) breeding, with March intermediate (1.53). Litter birth and weaning weights were larger (P<.05) following July (6.48 and 24.5 kg) than November (4.37 and 15.4 kg) and March breeding (5.27 and 20.3 kg). Litter average daily gain differed between seasons (P<.05) and ranged from 272 g/d for July breeding, to 244 g/d for March, and 196 g/d for November. Litter weight weaned as percent ewe body was not affected by mating season (range: 35-40%). Perinatal lamb survival was similar between breeding seasons (92-95%) and lamb survival to weaning ranged from 84% (March) to 92% (November). Reduced litter size and weights for November breeding in this study may have been associated with a younger ewe age. Data indicate that Katahdin hair sheep can be used in accelerated breeding systems; however, July breeding appears to coincide with the transitional period for seasonal breeding.

Key Words: Katahdin, Lambing performance, Accelerated breeding

1289 Vitamin E supplementation during late gestation and lactation on dam and lamb performance. D. G. Morrical* and A. Ali, *Iowa State University, Ames.*

The objective of this study was to determine if additional vitamin E provided orally to ewes during late gestation and lactation improved pre-weaning lamb performance. Two groups of ewes (123 and 72 hd) were used in the study during 1997 and 1998, respectively, in a split-plot design. Both years, ewes were grouped into four blocks according to ewe age and fetal counts. About one-half of the ewes from each block were supplemented orally with vitamin E (300 IU/hdd) and the other half received no additional vitamin E. Three days post-lambing, one-half of each block was switched to the other E treatment. A sub-sample of ewes and their lambs were monitored for serum vitamin E levels at d 3 pre- and post-lambing, mid lactation (d 28), and at weaning (d 56). Serum E at d 3 pre- and post-lambing was 1.9 and 1.3 mg/l for ewes supplemented with vitamin E during late gestation compared to 1.1 and .9 for non-supplemented ewes, respectively. Serum vitamin E level at d

28 was higher (P < .05) in ewes supplemented with E during lactation than non-supplemented ewes (1.5 and 1.1 mg/l, respectively). Lamb birth weight, weaning weight, and livability were not affected by vitamin E supplementation. Serum E levels at 3 d (P < .05) and 28 d (P < .10) were higher in lambs (1.9 and 1.4 mg/l, respectively) from dams receiving E in late gestation and lactation compared to lambs (1.4 and .9 mg/l, respectively) from non-supplemented ewes. It is our conclusion that additional E in late gestation and lactation had no effect on lamb pre-weaning performance due to excellent serum E levels in the control ewes.

Key Words: Vitamin E, Lamb, Growth

1290 Growth performances and retention rate of small ceramic boluses for electronic identification in fattening lambs. D. Garjn, G. Caja*, and C. Conill, *Universitat Autònoma de Barcelona, Bellaterra, Spain..*

An experiment was conducted to evaluate the effects of two sizes of bolus transponders in the electronic identification and growing performances of a total of 105 lambs (Manchega, n=69; and, Lacaune, n=36). Ceramic boluses were made in Alumina (Al₂O₃) according to the PCT/FR97/00744 patent, to be orally administered to young lambs. A glass encapsulated half-duplex passive transponder (32.5x3.8mm; Tiris[®]) was placed inside each bolus. Features (diameter x length and specific gravity) of empty boluses were: 'Mini' (M, 9.3 x 36.5 mm and 1.9g/cm³) and 'Small' (S, 15.0 x 39.1 mm and 3.3g/cm³) and final weights 5.6 and 20.0 g, respectively. Lambs were randomly assigned after birth to three experimental treatments (n=35 per group): Control (C, without bolus) and M or S boluses. Milk intake in suckling lambs was estimated weekly from wk1 to wk4 (weaning) by using the oxytocin method. Weaned lambs were intensively reared in groups and fed concentrate and straw *ad libitum*, and slaughtered when they reached 23kgBW. Bolus readability, BW and feed intake were recorded weekly and boluses recovered in the slaughterhouse. Administration of M boluses with a silicon probe was possible (95% confidence) during wk1 and health was not apparently altered after application. Administration of S boluses with a small balling gun was tested after weaning, but it was not feasible in all lambs until wk7. Bolus application did not affect (P>0.05) milk suckled (1.29l/d), concentrate intake (0.75kg/lamb) and growth rate (0.267kg/d) of M lambs during the suckling period. Feed intake (0.830 kg/d) and growth rate (0.309 kg/d) were also not affected (P>0.05) during the fattening period in M and S lambs. Bolus retention rates from application to slaughtering were 57.1 and 100 % for M and S boluses (P<0.001), respectively. All boluses were recovered in the rumen-reticulum, of these 83.3% of M and 77.8% of S were found in the reticulum. We conclude that boluses can be applied in very young lambs without negative effects on their growing performances. New designs are necessary to improve the retention rate of mini boluses if earlier application than 7 weeks is required.

Key Words: Transponder, Ruminal Bolus, Suckling Lambs

SWINE SPECIES

1291 The effect of age at first boar contact, feeding regime and lysine concentration in the diet on lifetime performance in female swine. M. Varley and M. Cole*, *SCA Nutrition.*

The rearing protocols used in swine breeding units for new gilt replacements have been open to question recently and in particular because modern genotypes are considerably leaner with higher mature weights compared to 20 years ago. It has also been suggested that for a long breeding life gilts should be given a diet in the rearing phase that contains reduced lysine and protein to promote increased backfat development at the time of first mating. A large-scale experiment was carried out at the SCA Feed Evaluation Unit (UK) at the time the unit was established with a new population of gilts to examine this question. 120 JSR breeding gilts were allocated at 60-kg liveweight to a 2x2x2 factorial experiment where the main factors were different elements of the rearing protocols. The 3 factors were; age at first boar exposure (180 days v 200 days), feeding regime (ad libitum v 80% ad libitum intake between 60 kg and first service) and lysine concentration in the diet (0.55% v 0.85%). At the appearance of first estrus all gilts were mated twice on consecutive days and from that time on the feeding and general management

was the same for all animals. They were then followed through 3 parities. Body weight, body fat, litter size and litter weights were measured and recorded. The culling patterns through the 3 parities were similar for all treatments but the animals on the low lysine diet in the rearing phase lost 23% of all females over 3 parities. The high lysine treatment lost only 13%. The number of piglets born alive per litter for parities 1,2 and 3 respectively were for gilts given boar introduction at 180 days of age: 11.1,11.9 and 13.2 and for gilts given boar exposure at 200 days of age were 10.6, 9.4 and 12.1 piglets (p<0.09). The management protocol, which gave maximum reproductive performance over 3 parities, was to expose the gilts at 180 days of age and to offer an ad libitum high lysine diet up to mating. It is concluded that body lean or protein mass may be a more important parameter than body fat per se in the formulation of management protocols for gilt replacements.

Key Words: Swine, Sow, Reproduction

1292 The effect of gender or gonadectomy on growth and plasma cholesterol levels in pigs. C Lee¹ and K Kim*², ¹*Cheju Agricultural Experimental Station, Rural Development Administration, Cheju, S. Korea*, ²*Department of Animal Biotechnology, Cheju National University, S. Korea.*

Studies were carried out to determine the effect of gender or gonadectomy (GDX) on growth and plasma cholesterol levels, using 10 male (26.1 kg) and 10 female (26.4 kg) pigs (Landrace), of which 5 from each sex were gonadectomized (GDX male and female) and the rest were sham-operated (Sham male and female). When these pigs reached an adult size (male 123, and female 99 kg), they were fed a diet containing 0.5% cholesterol and 0.1% cholate for 10 days. Plasma total cholesterol levels (mean \pm se) before (and after) feeding the high cholesterol diet in Sham and GDX male, and Sham and GDX female were 97 ± 8 (104 ± 22), 105 ± 12 (136 ± 23), 111 ± 11 (161 ± 28) and 107 ± 8 (160 ± 26) mg/100 mL, respectively. Plasma cholesterol levels were much higher ($P < 0.01$) in female than in male when pigs were fed the high cholesterol diet, and were increased by gonadectomy in male, but remained the same in female pigs. Gonadectomy increased ($P < 0.04$) average daily gain (0.88 vs 1.01 kg) only in female pigs. Results show that gonadectomy increases the plasma cholesterol level in male pigs and increases the growth rate in female pigs, suggesting that testosterone is at least partly responsible for the lower plasma cholesterol level in male, and estrogen for the lower growth rate in female pigs. Further studies are needed to determine how testosterone involves cholesterol metabolism when animals are fed a high cholesterol diet. Estrogen has been considered to be a stress hormone, increasing cortisol excretion and decreasing growth rate.

Key Words: Pigs, Gender, Gonadectomy, Cholesterol, Testosterone, Estrogen

1293 Arginine deficiency in 7- to 21-day-old suckling piglets. N.E. Flynn, D.A. Knabe, B.K. Mallick, and G. Wu*, *Texas A&M University, College Station.*

Arginine (an essential amino acid for piglets and required for hepatic ammonia detoxification) is remarkably deficient in sow's milk. Paradoxically, we discovered that intestinal synthesis of citrulline and arginine from glutamine/glutamate and proline (the major source for endogenous provision of arginine) decreases markedly in 7- to 21-d-old suckling pigs compared with newborn pigs. Our findings have raised an important question of whether arginine is deficient in suckling pigs. Although sow-reared pigs continue to grow during the 21-d suckling period, this does not necessarily imply that arginine supply from milk plus endogenous synthesis meets arginine requirements for optimal growth, as exemplified by suboptimal growth in arginine-deficient young rats. Indeed, recent artificial rearing studies indicate that the biological potential for neonatal pig growth is at least 74% greater than that for sow-reared piglets. Because of the practical limitation in conducting a nitrogen-balance study with suckling piglets, we decided to measure biochemical parameters (e.g., arginine and ammonia) in plasma as indicators of arginine status in piglets. Jugular venous blood samples (3 mL) were obtained from sow-reared piglets (10 males and 10 females) at 1, 3, 7, 14 and 21 d of age for analyses of plasma amino acids and ammonia by HPLC and enzymatic methods. Blood sampling was performed 1.5 h after suckling between 0930 and 1130. Data were analyzed by ANOVA for repetitive measurements. All measured parameters did not differ ($P > .05$) between male and female piglets. Body weights of piglets averaged 1.32, 1.42, 1.75, 2.55, 4.10 and 5.76 kg, respectively, at birth and 1, 3, 7, 14 and 21 d of age. Plasma concentrations of arginine and its immediate precursors (citrulline and ornithine) decreased ($P < .01$) progressively by 20-41%, but plasma ammonia concentrations increased ($P < .01$) progressively by 18-48%, in 7- to 21-d-old pigs compared with 1- and 3-d-old pigs. Plasma concentrations of other amino acids exhibited slight or no changes in piglets during the 21-d suckling period. Our results indicate a hitherto unrecognized arginine deficiency in 7- to 21-d-old pigs. An arginine deficiency may be an important biological factor for limiting optimal growth of sow-reared piglets.

Key Words: Arginine, Development, Pigs

1294 Optimal threonine:lysine ratio for growing pigs of different sexes. W. H. Chang¹, J. D. Kim¹, J. H. Lee¹, I. S. Shin², I. K. Paik³, B. J. Chae⁴, and In K. Han¹, ¹*Seoul National University, Korea*, ²*American Soybean Association, Korea*, ³*Chung-Ang University, Korea*, ⁴*Kangwon National University, Korea.*

This study was conducted to investigate the effects of threonine:lysine ratios on growth performance, apparent nutrient digestibility and blood urea nitrogen (BUN) concentration, and to estimate the optimal threonine:lysine ratios for growing barrows and gilts. A total of 150 pigs (LandraceXYorkshireXDuroc, 16.75 kg average body weight, 75 barrows and 75 gilts) was randomly allotted into six treatments in a 2X3 factorial design. Six diets were formulated to contain 1.12% lysine for barrows, 1.33% lysine for gilts, respectively, with three threonine:lysine ratios (50, 60 and 70%) for both barrow and gilts in the present study. Throughout the whole experimental period (16 to 56 kg body weight), there was no interaction between sex and dietary threonine:lysine ratio on average daily gain (ADG), average daily feed intake (ADFI) and feed conversion rate (FCR). Between sexes, there was a clear sex-effect showing better growth performance of barrows. Barrows ate more feed ($p < 0.01$) and grew faster ($p < 0.01$) than gilts did. For barrows, there was a trend to improve ADG and FCR with increasing threonine:lysine ratio. For gilts, there was a trend to improve ADG and FCR up to threonine:lysine ratio of 60%, but not significant. Between sexes, total BUN concentration was lower in gilts than barrows ($p < 0.05$). However, BUN concentration was not affected by dietary threonine:lysine ratios. In conclusion, 70 and 60% dietary threonine:lysine ratio for barrows (1.12% lysine) and gilts (1.33% lysine), respectively, tended to result in better growth performances and nutrient utilization and lower BUN concentration than other threonine:lysine ratios.

Key Words: Pigs, Threonine:lysine, Growth performance

1295 Effects of extruding corn and wheat grain on growth performance and digestibility of amino acids in early-weaned pigs. B. J. Chae¹, Y. K. Kim*¹, J. D. Kim², W. T. Cho², and I. K. Han², ¹*Kangwon National University, Korea*, ²*Seoul National University, Korea.*

This experiment was conducted to compare the effects of extruding corn and wheat on growth performance and digestibility of amino acids in early-weaned pigs. Corn and wheat ground by a hammer mill (3mm screen in diameter) were extruded at $130\pm 2^\circ\text{C}$ with a moist-type extruder (Matadora). Treatments were: 1) 3mm ground corn, 2) extruded corn, 3) 3mm ground wheat, and 4) extruded wheat. A total of 160 piglets (14 d of age and 4.3 ± 0.74 kg BW) were allotted with the dietary treatments for a 21 d feeding trial. All diets were mash and contained 30% corn or wheat products. The pigs were allowed ad libitum access to feed and water. For a digestibility trial, 16 piglets (14 d old and 4.2 ± 0.32 kg BW) were employed in individual cages. An additional 4 pigs were allotted to determine endogenous amino acid excretions with a nitrogen-free diet. Each pig was fed a restricted amount of feed (5% of BW/d) three times daily. On the sixth day after feeding, fecal samples were collected for 2 days. There were no significant differences ($p > 0.15$) in growth performance of piglets between corn and wheat. Extruding corn or wheat in the piglet diet had no effects on ADG ($p > 0.15$) and ADFI ($p > 0.15$), but it improved feed/gain ($p < 0.01$). Also, extruding corn and wheat reduced true fecal digestibilities of lysine and methionine ($p < 0.01$) in the piglets. In conclusion, our results suggest that extruding corn and wheat had no benefit on the growth rate of early-weaned pigs.

Key Words: Pigs, Extrusion, Digestibility

1296 Ileitis, intestinal microflora and performance of growing-finishing pigs fed *Saccharomyces cerevisiae*. A. A. Martinez*¹, L. E. Zapata¹, J. Sierra-Diaz¹, M. P. Perez-Olvera², R. P. Pradal², R. Mendoza², M. O. Velazquez-Madrado², and J. A. Cuaron¹, ¹*Centro Nacional de Investigacion en Fisiologia y Mejoramiento Animal, INIFAP*, ²*Universidad Nacional Autonoma de Mexico.*

From weaning (22d and 6.5 kg), 144 pigs were fed a sorghum-soy based diet \pm a live *Saccharomyces cerevisiae* (SC) culture (3 kg/ton of feed). Pigs were raised to 112d (50 kg body wt) on a healthy farm (S1), when 66 animals (33 fed SC) were moved to a farm where respiratory and digestive diseases were diagnosed (S2). Upon arrival, pigs were allotted to pens in groups of 5, 3 from S1 and 2 from S2 to insure infection and

as an added factor of stress. At S2, 5 treatments were established: (1) a negative control (no yeast or antimicrobial drugs); (2) no SC in S1, SC in S2; (3) SC in S1, no SC in S2; (4) SC in S1 and S2 and (5) a control treated with antibiotics. Feed intake was measured daily and body wt gain biweekly. At arrival to S2 and at d-21, 42 and 63, 3 animals per treatment were sacrificed to collect samples for microbial determinations from 5 portions of the digestive tract and to diagnose ileitis. No differences in performance ($P > .05$) were found from weaning to d-112. At S2, histopathology and bacterial findings were similar ($P > .05$), but presence of viable SC was confirmed. Pig ADG was greater ($P < .01$) when SC was fed, notably in S1 (736, 782, 731, 836, and 667 g/pig, for treatments 1 to 5). Pigs fed antibiotics had an ADG similar to those fed SC, but the response dropped after removal of the drugs (d-21 in S2). The experiment was repeated and results were similar. These data suggest that pigs fed SC prior to challenge and through finishing had more resistance to stress.

Key Words: Growing-finishing Pigs, Yeast, Stress, Disease Resistance

1297 Effect of selection for improved piglet survival on prenatal development. J.I. Leenhouders*¹, T. Van der Lende¹, and E.F. Knol², ¹Wageningen Institute of Animal Sciences, Wageningen University, The Netherlands, ²Institute for Pig Genetics, Beuningen, The Netherlands.

The objective of this research was to investigate the effect of selection for improved piglet survival on prenatal development. Estimated breeding values for piglet survival (EBVps) were calculated using data on piglet survival in nucleus herds of the Dutch breeding company TOP-IGS. Piglet survival was defined as an all or none trait between onset of parturition and weaning. Crossbred gilts (n=46) were mated to boars from a boar line (n=14). Both gilts and boars had known EBVps. Mating was performed in such a way that a wide range of EBVps of litters was achieved. On day 111 ± 1 of gestation, fetuses were removed by Caesarian section. Data on fetal length and weight, placental characteristics and various fetal organ weights were collected. Statistical analysis was performed on litter averages. The statistical model included the fixed effect of stage of gestation and the covariables average fetal weight, number of fetuses (excluding mummies and macerated fetuses), percentage of males within the litter and EBVps. Significance was tested by the general linear models procedure, using stepwise elimination of non-significant ($p > 0.05$) effects. Variation in placental weight within the litter decreased with increasing EBVps ($p < 0.05$). EBVps had a negative effect on average fetal length ($p < 0.05$) and a positive effect on average fetal liver weight ($p < 0.05$). Preliminary data on liver glycogen content of 64 fetuses from 34 litters showed that, after adjustment for fetal weight, 49% of the variation in fetal liver weight is explained by variation in liver glycogen concentration. We conclude that selection for improved piglet survival increases uniformity of placental weight within a litter, decreases average fetal length and increases average fetal liver weight. Furthermore, selection may increase fetal liver glycogen content.

Key Words: Genetic Selection, Piglet Survival, Prenatal Development

1298 Non-invasive cryopreservation of zona pellucida intact morulae stage pig embryos: Birth of multiple litters of piglets after embryo transfer. J. R. Dobrinsky*¹, H. Nagashima², V. G. Pursel³, L. L. Schreier¹, and L. A. Johnson¹, ¹USDA-ARS, GGPL, Beltsville, Maryland, USA, ²Meiji University, Tama, Kawasaki, Japan, ³USDA-ARS, GEML, Beltsville, Maryland, USA.

Methods exist to adequately, but not optimally, preserve embryos from genetically superior animals of most of our livestock species except the pig. Whole early stage pig embryos up to the morula stage have not developed after cryopreservation. Our objective was to develop

non-invasive methodology to cryopreserve zona pellucida intact morulae stage pig embryos. After a technologically-protected pre-treatment of pig morula, embryos were cryopreserved by vitrification. After indefinite storage, embryos were recovered and rehydrated. After a technologically-protected post-cryopreservation treatment was applied to the embryos, all embryos were cultured further in vitro. Survival in vitro was $>80\%$. Viable embryos were surgically transferred to recipient females. In the first trial, 3 gilts farrowed 8, 7 and 4 live and healthy offspring. In a validation trial, 6 of 7 gilts farrowed 42 offspring. Total pregnancy rate was 9/11 (82%) with 61 total piglets born averaging over 6 pigs per litter. This research utilizing technologically-protected, novel methodology produced the first live offspring from non-micromanipulated and vitrified, zona pellucida intact morula stage pig embryos. The methodology provides an avenue for the long term preservation of embryos that can be transported and later transferred internationally. Morulae stage embryos are ideal for surgical or non-surgical embryo transfer in the pig, as these are uterine stage embryos that possess a full, non-thinning zona pellucida, ideal for aseptic embryo washing and transfer. Our previous work, and this novel methodology provide procedures that will allow the cryopreservation of all early stages of preimplantation pig embryos, from zygotes to hatched blastocysts. Implementation of methodologies for long-term embryo preservation and transfer in swine would provide a foundation for effective utilization of the world's most valuable genetic resources on a global basis while modernizing pork production and enhancing genetic improvement programs.

Key Words: Pig, Embryo, Cryopreservation

1299 The use of electrical impedance spectroscopy (EIS) for pig meat quality selection. M.A. Oliver*¹, I. Gobantes¹, J. Arnau¹, J.M. Monfort¹, J. Elvira², P.J. Riu³, and N. Gr̄sol⁴, ¹IRTA-CTC, Girona, Spain, ²NTE, S.A. Barcelona, Spain, ³UPC, Barcelona, Spain, ⁴Esteban Espuna, S.A. Girona, Spain.

Meat quality (pHu) and fatness are important characteristics in the production of dry-cured ham. Measurements of meat quality were made on 95 commercial hams (11.06 ± 0.76 kg) to evaluate the relationship between quality characteristics (ham weight, conformation, fat thickness in the rump (1.19 ± 0.61 cm), visual fatness and pHu in the *Semimembranosus* (SM) and electrical parameters, Ro, Rinf, Rinf/Ro, Fc and α obtained with the EIS equipment. Ro and Rinf are the electrical impedance (Ω) of the system at low and high frequencies, respectively. Fc is the frequency (kHz) at which the complex component of the electrical impedance is highest and α is an adjustment parameter. The measurements were carried out at 36 h p.m. in two regions of the ham (SM and *Biceps femoris* (BF)). A general linear model (least square means and SE) of the electrical variables on three different pHu categories were performed: LWHC (low water holding capacity) pHu < 5.65 , IQ (Ideal Quality) $5.65 \geq$ pHu < 5.95 and DFD group pHu ≥ 5.95 . Correlation coefficients between all variables were also determined. Significant differences ($p < 0.01$) were observed between the DFD and IQ groups with respect to LWHC group for Rinf/Ro (0.31 vs 0.49 in SM region, and 0.38 and 0.47 vs 0.57 in the BF region) and Fc variables (32.9 and 29.2 kHz vs 50.6 in SM region, and 39.7 and 53.4 vs 68.0 in the BF region). α parameter was significantly different in the SM region between LWHC and IQ groups (0.31) with respect to DFD group (0.29). pHu values were moderately correlated ($p < 0.05$) in SM region with ratio Rinf/Ro, Fc and α , and in BF region with ratio Rinf/Ro and Fc. In the BF region, visual fatness and fat thickness were significantly correlated ($p < 0.05$) with Ro and Rinf. This study suggests that with EIS we can obtain objective information about the meat quality and fatness of the hams at 36 h p.m. Both parameters are important to optimise dry cured ham selection.

Key Words: Meat quality, Electrical impedance spectroscopy, Dry-cured ham

UNDERGRADUATE AND GRADUATE EDUCATION

1300 A tool for creating online programmed instruction lessons. D.M. Forsyth* and D.L. Lofgren, *Purdue University, West Lafayette, IN.*

A program has been developed for the creation and delivery on the World Wide Web of programmed learning lessons. Programmed learning is an active learning method involving repeatedly delivering a small amount

of information followed by a question, with the answer determining the subsequent path of the lesson. Programmed learning was popular in the 1960's and 70's but was text based, or included graphics requiring high levels of programming. Operating system and programming language changes made many programs inoperable or obsolete and much that was developed fell into disuse. Use of the World Wide Web as a

delivery vehicle helps to alleviate some of the past obstacles. Delivery is possible to a wide and distant audience, and lesson delivery can be independent of the user's particular computer. The use of HTML for lesson development allows a (hopefully) stable and standard, open language for the development of a majority of the lesson material. It also allows incorporation of visual graphics, sound, and hyperlinks to material outside the lesson. The developed program replaces the need for lesson-specific cgi-scripts. The instructor writes the lesson as a series of web pages. The interactive portion of the program aids the instructor in the creation of files which provide the necessary information for lesson delivery, such as: correct answers; incorrect anticipated answers; the response to provide for each answer type; where to continue after a particular answer is received; and how many tries are allowed for a question. The answer types allowed include multiple choice (radio buttons), numeric responses, and string responses that include wildcard matching. In delivery mode, the program evaluates the answer given by the student, returns the appropriate response, and continues the lesson at the correct place. The program registers the student into the lesson at the beginning and logs all responses. Fifteen lessons have been created for an animal nutrition course.

Key Words: Programmed Learning, Internet

1301 Problem-based learning in distance education.

L.G. Griffiths*, S. L. Kitto, J. Pesek, E. Mackenzie, and K. Bauer, *University of Delaware, Newark.*

In 1997, we added distance students to a traditional, classroom-taught agricultural biotechnology course. To reach distance students, we used a multimedia approach: lectures via videotapes and problem-based learning exercises (PBL) via the Internet. About a third of the course was taught using PBL. The major challenge of the course was to teach the PBL segments to distance and traditional students working together in groups. We explored ways to use multimedia technology that would allow distance students to participate in the PBL segments of the course. To assess the effectiveness of the methods used in this project, we compared the distance students with traditional students using measures of perceived and actual knowledge of biotechnology. Group (distance vs traditional students) comparisons were made using cumulative grade point average prior to taking the course as a covariate to adjust for differences in ability between groups. The student-student interactive PBL segments were challenging because the traditional students were working in 'real time' and the distance students were working in 'distance time'. Distance students did as well as in the course as traditional students; however, management of groups composed of distance and traditional students was challenging. PBL could probably be used more effectively/successfully with student groups composed solely of distance students.

Key Words: Problem-based Learning, Distance Education, Biotechnology Education

1302 Development of porcine myology manual on CD-ROM. S.J. Jones¹, D.E. Burson¹, and J. Bulter¹, ¹University of Nebraska, Lincoln.

Understanding of the myology of the pig is important in the pork industry as well as for research and teaching. Today more boneless cuts are being marketed and muscle separation is becoming routine operation in the cutting process. With the advent of technology such as the computer and the internet, it is possible to present information in an organized manner that is easily accessible to a single student or a large number of people. The objective of this project was to develop a porcine myology manual which could be produced in a digitized form stored on a CD-ROM. This could be used on a computer to allow the learner to have more interaction with the manual. A 82 kg carcass was frozen and then separated into right and left sides. The right side was cut into cross-sections 1 inch in thickness then photographed to show the longitudinal progression of muscles and their relationship to the skeleton and to fat deposits. Cross-sectioning began just anterior to the tibiotarsal joint and continued to the atlanto-occipital joint. Fifty six cross-sections were made through the whole carcass. The shoulder section of the left side was cross-sectioned by make cuts parallel to the front limb just above radiocarpal joints. Eighteen cross-sections were made through this portion of the carcass. A second 110 kg pig was slaughtered and chilled then the right side was dissected by removing muscle layers and photographed. A strobe lighting system was used in lighting the cross-sections and lateral

layers during photography. Photographs were digitized to JPEG format for use in the CD-ROM development. Information on each muscle was collected including; name, origin, insertion, action, innervation, blood supply, wholesale and retail cut location. Programming of the CD-ROM was done using HTML language and JAVA script so that the program could be used with a web browser on a computer. Drawings of each cross-section and lateral cuts were drawn, then formatted as a GIF file then linked to each muscle information file. The porcine myology CD will provide a valuable resource for both academia and industry

Key Words: Porcine Myology, HTML, CD-Rom

1303 The organization of the Texas College Equine Teaching Consortium. H.A. Brady*, Texas Tech University, Lubbock.

The Texas College Equine Teaching Consortium was established in 1999 to foster networking among Texas universities, colleges and junior colleges. There are 55 colleges and junior colleges in the state of Texas, over half of which have an equine program or emphasis. Very little communication has existed between these programs. Needs throughout the state have included an awareness of other programs and areas of emphasis. To facilitate this, an internet web page and discussion site have been established for all members. Through this, questions can be posted, ideas can be shared, and events and short courses can be rapidly listed. The consortium goals include a sharing of resources among these equine programs and to develop partnerships in distance teaching. Through this internet association, internship opportunities can be expanded both between colleges and in areas of the equine industry. A yearly meeting is being planned in association with the Texas Equine Industry Conference in College Station to discuss teaching strategies and cooperative efforts. This teaching consortium may develop into a model which may be useful nationally between equine teaching programs.

Key Words: equine, teaching, internet

1304 Undergraduate program curricular challenges and future trends. G. R. Gallagher*, R. L. Gallagher, and B. D. Holder, Berry College, Mt. Berry, GA.

The objective of this study was to evaluate current and future trends in undergraduate animal science programs. A survey was e-mailed to department chairs of 75 public and private institutions offering 4-year degree programs in animal science. Two questions were based on ranking current and 10-year prediction of species emphasis. The remaining two questions requested a list of the three greatest challenges in undergraduate programs currently and in 10-years. The 32 (45%) institutions responding to the survey were divided into 4 geographical regions, North (N)(n=3), South (S)(n=9), Midwest (MW)(n=8) and West (W)(n=12). Nationwide information was derived by combining responses from all regions. The four highest rankings were used for analysis of species emphasis. Currently, 93.4% of institutions responding have beef cattle programs with species emphasis in the highest 4 rankings followed by horse (81.3%), swine (62.5%), sheep (59.4%), dairy (56.3%), poultry (25.0%) and domestic pets (18.9%). Predicted species emphasis in ten-years suggests no change in maintaining beef cattle programs. Decreased emphasis was predicted for swine (-15.6%), dairy (-9.4%) and sheep (-6.3%). Decreased emphasis in swine was predicted for S and W, dairy predominately in the S and sheep in the N and S. Predicted increase in domestic pets (+18.9%) occurred in the S and W, and horse programs (+6.2%) in the N and MW. No changes were predicted for poultry. Challenges facing undergraduate programs were similar for all regions and both time periods. The most frequent responses were: 1. Cost of maintaining livestock facilities, 2. Identification and retention of qualified faculty, particularly those interested in teaching and having livestock experience, 3. Lack of flexibility necessary for timely alteration of curriculum, 4. Students from an urban background and, 5. Identification and recruitment of quality students. This study suggests significant changes are predicted to occur in animal science programs.

Key Words: Survey, Animal science, Undergraduate programs

1305 Pigwatch: a group project for an introductory animal science laboratory. G. Apgar*, *Southern Illinois University, Carbondale.*

An introductory livestock production lab is offered during the fall semester at SIUC. Students were placed into groups of 5-7 and required to spend 12 hr observing a sow and her litter. The group recorded data such as piglet wt, sow activity, suckling placement and piglet activity, and attempted to explain findings. Posters were prepared by each group to outline findings, displayed, and evaluated by students, faculty and staff. Poster scores were a combination of scores from poster evaluations and individual evaluations by group members. The winning poster has been displayed for the year. Students were polled (n=68) using a 5 point scale (1=strongly disagree; 3=no opinion; 5=strongly agree) to measure acceptance of the exercise across the majors in the class. The questions asked were: 1) Exercise helped my understanding of animal behavior 2) I thoroughly enjoyed it 3) My group functioned well as a group 4) Poster evaluations were fair 5) Individual evaluations were fair 6) This is my first experience with a sow 7) I am pleased with my grade 8) Should be continued for future classes 9) Gender 10) Grade-point average 11) Class rank and 12) Major. The class consisted of majors in agribusiness economics (ABE, 4.4%), agriculture education (AGED, 4.4%), animal science (ANS, 39.7%), general agriculture (GNAG, 26.5%), and zoology (ZOO, 13.2%) and other (11.8%). Responses to "group functioned well as a group" ranged from 4.0 to 4.67 across majors indicating that groups fared well in working together. Responses to "poster evaluations were fair" and "individual evaluations were fair" ranged from 4.14 to 4.67, and 4.11 to 5.0, respectively. Response to "this is my first sow experience" showed students in ANS were second to ZOO majors in lacking sow experience (3.7 vs. 4.2), while AGED majors had the most experience (1.33). Student response to "should be continued in future classes" was strongly positive (range 4.6 to 5.0) across majors. This exercise has introduced students to swine behavior, data capture, and allowed the opportunity to teach and/or learn from students in other majors.

Key Words: Swine, Teaching, Group project

1306 Study abroad: A model program in New Zealand. L. G. Griffiths¹, S. E. Truehart*¹, and N. G. Gow², ¹*University of Delaware, Newark,* ²*Lincoln University, Canterbury New Zealand.*

In January 1999, 39 undergraduate students, two faculty members and one teaching assistant arrived in Christchurch, New Zealand to begin a 30 day exploration of "Agriculture Down Under" with Lincoln University serving as the host site. The students enrolled in two courses, both taught by the visiting faculty in Lincoln University facilities. Host faculty from Lincoln University provided occasional guest lectures. In addition to attending two daily lectures, students took approximately three field trips per week. The trips included both agricultural sites and locations where the student could experience New Zealand and Maori culture. Agricultural sites included a high country station with 22,000 acres and 5,500 sheep, a low-country irrigated station with 500 dairy cows and 4,500 sheep, and Mt Peel, one of the oldest stations on the South Island with beef cattle, red deer and sheep. We also visited a dairy, swine farm, red deer farm, Japanese beef feedlot and a equine breeding facility with over 500 brood mares. Cultural and other sites included the French settlement of Akaroa, a Maori village, the botanical gardens, Canterbury Museum and the International Antarctic Centre. Honors students were assigned the role of a documentary film crew and they collected over 10 hours of tape, which were edited, to a one-hour film upon return to the United States. Honors students interviewed each farm host and extended our thanks and a personal gift before we left each station. The daily lecture and field trip schedule provided a fairly rigid structure for the students. They were provided with single dorm rooms and we all ate meals together in the dining halls when on campus. Lincoln University offers an extremely economical package for housing and meals, which made the cost of the trip quite affordable. The faculty and staff at Lincoln arranged and escorted us on all of our agricultural tours. Students commented that the unique combination of agriculture, New Zealand culture and Maori culture made the trip a lifetime experience!

Key Words: Study Abroad, New Zealand, Undergraduate

1307 Using excel spreadsheet to teach feed formulation. V. Pattarajinda*, M. Duanginda, and M. Froetschel, *University of Georgia, Athens.*

Ration formulation programs were developed using Excel Spreadsheets and NRC guidelines to teach Animal and Dairy Science majors applied nutrition in a feeds and feeding course. A fundamental level of programming (FL) is taught initially and then it is advanced to least-cost programming (LC). The FL approach allows students to visualize the equations and improve their conceptual understanding of ration formulation. Separate programs are used for different species of livestock but each operates in a consistent manner and requires minimal time for orientation. Initially students are taught to formulate by setting the amounts of feed ingredients in a ration to equal nutritional requirements by repetitively using the formula: amount fed x nutrient concentration = amount of nutrient. The FL program uses economic replacement values of individual feeds based on the energy and protein content and prices of corn and soybean meal as a guide to select feeds economically. In addition to the spreadsheet, the FL programs contain a one page feed report that contains mixing specifications and a feed inventory. The LC approach was designed specifically for dairy cattle feeding, it is menu driven and displayed in a streamlined design written with visual basic language. There are three main menu sections to the LC program: 1) NRC requirements and 2) feed ingredient inventory that contains, restriction settings, nutrient specifications and cost and 3) least-cost formulation that uses the solver function in EXCEL. The LC program is controlled as other linear least-cost programs and can formulate total mixed rations or concentrates. Teaching the FL and LC programming in feeds and feeding uses readily available software to provide training for students entering careers in both the feed industry or production agriculture.

Key Words: Ration, Feed Formulation, Least cost-program

1308 Usage of hands-on activities to enhance interest and facilitate learning in an undergraduate feeds and feeding course. B. A. Reiling* and J. H. Brendemuhl, *University of Florida, Gainesville.*

Courses in applied nutrition and diet formulation are often perceived by students to be a test of their mathematical ability. In 1999, we incorporated a variety of simple hands-on activities within each laboratory session to motivate and facilitate the learning of basic feeding concepts. Upon conclusion of the course, students (n = 20) were surveyed to determine how the hands-on activities affected their interest and if they effectively enhanced learning. Nineteen of 20 students surveyed indicated that the hands-on activities facilitated their learning, and 98 ± 3% reported that the activities enhanced their interest in the course material. However, 40% of the students indicated that some activities required too much time to complete in relation to the knowledge gained. All activities conducted during the year were scored using a 1 (no educational value) to 5 (extremely valuable) scale. Scores for 10 weekly laboratory activities ranged from 2.95 ± .22 (determination of mineral solubility) to 4.60 ± .11 (feed identification) with an overall average score of 3.61 ± .19. Six different computer applications were used and scores ranged from 3.45 ± .21 (relative feed value spreadsheet) to 3.95 ± .20 (Apollo least cost formulations) with an average score of 3.72 ± .22. In addition, students working in groups conducted both a swine digestibility and chick feeding trial. The swine digestibility project scored 3.95 ± .19, and 95% of the students indicated that the project should be continued. The 3-week chick feeding trial gave students an opportunity to visualize the effect of various nutrient deficiencies. The project scored 3.90 ± .25, and 75% of the students indicated that the project should be continued. In fact, 50% of the students indicated that the chick feeding trial should have been extended another 2-3 wks. In conclusion, it appears that hands-on activities were successful in motivating and facilitating student learning in an undergraduate feeds and feeding course.

Key Words: Experiential learning, Hands-on, Nutrition

1309 Fostering student active-based learning in a senior level meat science course. E. P. Berg*¹, ¹*University of Missouri, Columbia.*

As part of the course requirement for *Physiology and Biochemistry of Muscle as Food*, students are required to organize, prepare, and present

what will become their textbook which is centered on a specific aspect of meat science and (or) muscle biology. On the first day of class students are asked to write down a question pertaining to muscle (meat science, muscle biology, or growth and development). This initial assignment provides the instructor with information regarding the level and area of student interest in the broad field of meat science. From this information, the instructor can pick a broad focal point (such as The role of meat in a healthy diet) and assign a more specific topic to the individual students. The students are asked to prepare a literary review of the assigned topic and consider the paper as a textbook chapter. Students are required to research the topic, prepare an outline, write a 5-6-page paper regarding this topic, and present one 20-minute lecture. All papers are compiled by the instructor, edited, arranged in a book format, and distributed to the class prior to initiation of the student lecture section of the course. The instructor and the students of the course evaluate each student lecture. Students are also responsible for preparing 2 exam questions and answers from their respective lecture. The final exam is then developed from these questions. This format of classroom instruction is built upon the idea that individuals learn more when they have to instruct another. Often the University system is criticized for failing to instill job related skills in its students. Preparation, organization, and oral presentation skills as well as the ability to work as a team member are traits that are strongly sought after by potential employers. This style of active learning provides students with valuable job related skills and a better understanding of meat science.

Key Words: Meat Science, Teaching, Active Learning

1310 Experiences with increasing student responsibility for learning in a low enrollment course. G. E. Shook* and L. Tong, *University of Wisconsin, Madison*.

An innovative teaching approach designed to shift the focus of the classroom toward the students was implemented in a three credit, senior level

course in dairy cattle breeding. Goals included both professional and cognitive development of students. This was accomplished by making learning a collaboration between students and instructor and emphasizing long term learning over short-term recall. Students participated in selection of topics. Daily reading assignments of carefully selected scientific journal articles were accompanied by a writing assignment to stimulate thoughtful study and hold students accountable for the reading. Class periods were devoted to discussion of the reading. Content of the discussions was driven by student-generated questions with answers provided by students. The instructor served as facilitator and resource person. As needed, the instructor corrected misconceptions among students and gave impromptu mini-lectures to clarify concepts and fill information gaps. The course was structured to encourage students to take risks, try out their own ideas, and make mistakes without penalty or embarrassment. To this end, grading was based 60% on participation elements and 40% on quizzes and exams. Throughout the semester, the instructor participated in a teaching circle of six faculty in diverse fields convened by a professional in biology education. One member of the teaching circle observed one class and a member of the departmental faculty interviewed the class collectively to evaluate progress. Students completed an extensive written evaluation at the end of the semester. The following quotations are representative: "The discussion format has proven to be much more effective and thought-provoking than the conventional lecture style. More importantly, I also feel like I will actually remember what I have learned." "It was necessary to be at the class always because discussion is where I learned the most." The grading policy " . . . was good because it didnt scare me away from trying." Students embraced this dynamic, interactive learning environment.

Key Words: Student-Centered Teaching, Active Learning

WOMEN AND MINORITY ISSUES IN ANIMAL AGRICULTURE

1311 How do we fit into ADSA/ASAS: International, minorities, women. W.A. Samuels*, *Solutia, Inc., St. Louis, MO*.

The need to achieve goes beyond borders, ethnicity and gender. The need to be accepted penetrates deep and is often a need shared by many. Depending on what is driving an individual, one of these needs may be satisfied; if one is left unmet, a void is created. Persistent individuals are driven to fill unmet needs. Whether an Internationalist, a minority or a female, the needs are the same. They have a need to contribute;

and when results are accomplished, they have a need to be recognized for their contributions. Our associations can be the vehicle to create the initial launch pad to fill unmet needs. ADSA/ASAS must be an incubator where ideas are shared globally and where individuals, regardless of their accents, ethnicity and gender, can believe that they belong. This presentation will focus on how an Internationalist, like myself (born and grown up in Jamaica), and a minority in my professional organizations, fits into ADSA/ASAS, and lessons learned along the way.

Key Words: Minorities, International, Women

ADDENDUM

The abstracts below were omitted from the following sections but can be found elsewhere in this publication as noted :

BREEDING AND GENETICS

Abstract number 1012 can be found in the Production and Management Section

NONRUMINANT NUTRITION

Abstract number 1232 can be found in the Ruminant Nutrition Section

The following abstracts were inadvertently omitted from the program :

FORAGES AND PASTURES

1312 An evaluation of the feeding value of bluegrass straw pellets for growing beef and dairy heifers. J.J. Michal*, J.A. Jewett, K.A. Johnson, R.L. Kincaid, J.D. Cronrath, and S.M. Smith, *Washington State University, Pullman*.

Three studies were conducted to evaluate the feeding value of bluegrass straw pellets (BP). Holstein heifers (n=36; 247 kg) were assigned to one

of 3 levels of BP (0, 11, and 22% BP). The BP replaced alfalfa silage in the diet (DM basis). Growing beef heifer calves (n=53; 298 kg) were assigned to diets where BP were included at 0, 15 or 30% of DM. The BP replaced alfalfa hay on a DM basis. Dairy and beef heifers were fed these diets for 60d. The BP contained (DM-basis) 11.8% CP, 51.7%

NDF, 30.8% ADF, 2.16% EE, 9.8% ash, total nonstructural carbohydrates 24.5%, 17% Ca, .16% P, .08% Mg, .52% K, .05% Na, 14 ppm Zn, and 2 ppm Cu. The dairy heifers consumed an average of 6.8 kg/d during the first 30d. During the second 30d, dairy heifers fed 22% BP tended to consume more DM (9.9 vs. 8.5 kg/d). Over the 60d trial, dairy heifers fed the BP had greater ADG ($P < .02$) than heifers fed 0% BP ($.97 \pm .11$ vs. $.82 \pm .09$ kg/d). There was no difference in ADG of dairy heifers fed 11% or 22% BP. Beef heifers fed 30% BP had higher ADG ($1.04 \pm .04$ kg/d; $P < .01$) than heifers fed 0% or 15% BP ($.82 \pm .04$ and $.77 \pm .04$ kg/d, respectively). Beef heifers fed 30% BP for 60d tended to have greater feed intake (9.4 kg/d) than heifers fed 0% BP (8.6 kg/d) or 15% BP (9.1 kg/d). Predicted NEm and NEg were 1.63 Mcal/kg and 1.09 Mcal/kg, respectively. Ruminally-fistulated cows

($n=3$) were used to determine the dry matter disappearance (DMD) of BP, bluegrass straw (BS) and pea hay (PH). The diets consisted of (DM-basis): PH, 100% PH; BP, 46.5% BP, 46.5% PH; BS, 45% BS, 45% PH. Soybean meal was added to the BP and BS diets to equal the CP of PH. Cows were adapted to their diets for 21d. Nylon bags ($n=4$) of PH, BP and BS were incubated in situ for 0, 4, 8, 16, 24 and 48h. The DMD of PH was 68% at 24h and 75% by 48h. In contrast, the DMD of BP was 42% at 24h and 59% at 48h. The DMD of BS was the lowest, 39% at 24h and 51% at 48h. BP can be used to replace moderate quality forage for growing dairy and beef heifers.

Key Words: bluegrass, straw, heifers

RUMINANT NUTRITION

1313 Effect of protein level in prepartum diets on the performance of dairy cows during the periparturient period. A.F. Park, J.E. Shirley, E.C. Titgemeyer, M.J. Meyer, and M.J. VanBaale, *Kansas State University, Manhattan.*

Multiparous Holstein cows (75) were used in a randomized block design to determine the level of dietary protein required to support metabolic functions and enhance body reserves during the periparturient period. Cows were blocked according to expected calving date and assigned to one of five diets: 9.7, 11.7, 13.7, 14.7, or 16.2% CP. Dietary treatments were initiated 28d prior to expected calving date and fed until parturition. Cows were fed a common diet postpartum. Dry matter (DMI) intake and milk yield was recorded daily through 90d postpartum. Full lactation milk yield and components were obtained from DHIA records. Prepartum DMI was 15.6, 15.9, 15.6, 16.3, and 14.6 kg/day for cows fed 9.7, 11.7, 13.7, 14.7, and 16.2% CP, respectively. DMI decreased 20, 19, 19, 23, and 29% between week 3 and week 1 prepartum for cows fed 9.7, 11.7, 13.7, 14.7, and 16.2% CP, respectively. Cows fed 16.2% CP were in negative energy balance (NEB) during the last 14d prepartum while cows fed the other diets experienced NEB during the last 7d prepartum. The relationship between prepartum diet and postpartum energy balance was best described as cubic ($P=.01$) with cows fed 14.7% CP being most negative and remained negative longer than cows fed other diets. Daily milk yield (quartic, $P < .05$) during the first 90d postpartum was lower for cows fed 13.7% CP but similar among other diets. Response to rbST during the ninth week was influenced ($P < .05$) by diet. Cows fed 13.7 and 14.7% CP exhibited the strongest response while cows fed 9.7% CP responded with 0.62 kg/d and those fed 16.2% respond. Cows fed 16.2 and 9.7% CP produced 1156 and 800 kg less milk, respectively during the subsequent 305d lactation than those fed 14.7% CP. The incidence of sub-clinical ketosis was 6.6, 20, 6.6, 0.0 and 27% for diets 9.7, 11.7, 13.7, 14.7, and 16.2% CP, respectively. These results indicate that using 14.7% crude protein with 35% NSC in the close-up diet for dairy cows produces beneficial outcomes during the subsequent lactation.

Key Words: Dairy, Protein, Periparturient

1314 Meta analysis of multiple responses of dairy cow to diet NDF content. D. Sauvant*¹ and D. R. Mertens², ¹*Institut National Agronomique, Paris, and* ²*US Dairy Forage Research Center, Madison, WI.*

Dairy cow responses to dietary NDF variations are essential to develop management programs. Therefore a data base was pooled from 100 published experiments (243 observations) where the diet NDF, or concentrate, content was the experimental factor. The following parameters were collected: dry matter intake (DMI = 3.41 ± 0.47 % LW), dietary NDF content (NDF = 34.2 ± 8.0 , min = 18.2, max = 59.3 % diet DM), dietary NDF intake (NDFI = 1.15 ± 0.23 % LW), milk yield (MY = 28.6 ± 6.7 kg/d), and milk contents of fat (MFC = 3.63 ± 0.52 %), protein (MPC = 3.20 ± 0.25 %) and lactose (MLC = 4.71 ± 0.16 %). Data were analyzed with the GLM procedure to separate between (BV) and within trial variance. The within trial variance was captured by a curvilinear combination of NDF and NDF2.

Increased dietary NDF systematically decreased DMI in the studied range of NDF (DMI = $3.38 + 0.035$ NDF -0.00094 NDF², $n = 230$, $nexp = 94$, $R^2 = 0.91$, $rsd = 0.18$) but it increased NDFI until NDF = 51.3 %DM and NDFI = 1.38 %LW (NDFI = $-0.36 + 0.068$ NDF -0.00066 NDF², $n = 230$, $nexp = 94$, $R^2 = 0.96$, $rsd = 0.06$). MY was depressed by increased NDF (MY = $34.2 - 0.0049$ NDF², $n = 243$, $nexp = 100$, $R^2 = 0.99$, $rsd = 1.8$). Dietary NDF was related negatively to MPC (MPC = $3.31 - 0.000091$ NDF², $n = 222$, $nexp = 90$, 0.93 , $rsd = 0.09$) and MLC (MLC = $5.36 - 0.0093$ NDF, $n = 92$, $nexp = 38$, $R^2 = 0.94$, $rsd = 0.05$) and positively to MFC (MFC = $1.69 + 0.086$ NDF -0.00080 NDF², $n = 219$, $nexp = 89$, $R^2 = 0.91$, $rsd = 0.20$). The sd values of BV were large for all the items: 0.59, 0.21, 9.1, 0.36, 0.70, 0.23 for DMI, NDFI, MY, MPC, MFC and MLC respectively. These variations were closely related for DMI and RMY ($R^2 = 0.66$). The proposed equations can be used to explore the marginal responses of variables to changes in dietary NDF in a given situation.

DAIRY FOODS

1315 Formulation and processing of reduced-fat dairy emulsions on the bench-top scale. M. T. Dineen* and K. L. Parkin, *University of Wisconsin, Madison.*

Margarine and table spreads composed of vegetable oils or vegetable oil/milkfat blends have become increasingly popular with consumers. Milkfat fractionation and blending enables the manufacturer to produce a tub-margarine like spread that is entirely composed of milkfat. Spread products at the commercial and pilot scale are manufactured in a three phase continuous process, with a minimum batch size requirement of 30 Kg for pilot plant trials. The objective of this research was to develop a bench-top method of making emulsions that emulates the pilot scale process, and to use this system to study the influence of formulation and processing parameters in preparing reduced-fat dairy spreads. Such a scaled-down approach would allow for savings in material and human resources, and accelerate product and process development. Studies have focused on preparing 60% and 40% spreads using a spreadable butter blend. Coarse emulsions (200 g batch size) were first formed us-

ing a 50°C water bath at 400 rpm with a Servodyne mixer system. A scraped-surface heat exchanger was then simulated using a tempering beaker with controlled agitation and coolant temperature. Monacylglycerols (MAG) levels (0-3% of milkfat phase), and processing parameters of cooling rate (bath temperature 3, 6 and 9°C), end product temperatures (10, 13, 16°C), and extent of working were evaluated. Quality of prepared products was indexed by measurement of emulsion stability (centrifugation), color/appearance (reflectance colorimetry), morphology (photomicroscopy), and textural analysis. Statistical analysis, (ANOVA) of data for 60% lipid spreads indicated that significant differences between sample quality were conferred by variable processing temperatures but not MAG levels. Log transformations of these data correlated processing time with colorimetry values and processing time with textural (spreadability) parameters. Quality of emulsions prepared with a 40% lipid phase were more influenced by MAG level than processing parameters. Ideal conditions for preparing 40% and 60% milkfat spreads using the bench-top system were with a 6°C coolant and a 13°C final product temperature.

ABSTRACTS STUDENT AFFILIATE DIVISION

* Author Presenting Paper

DAIRY FOODS UNDERGRADUATE PAPER PRESENTATIONS

SAD1 Is milk really the problem? Lactose intolerance products. M. D. Browning*, *Virginia Tech, Blacksburg.*

Lactose intolerance in humans has become a regular occurrence in today's population. It is more common to be lactose intolerant than it is to be lactose tolerant. A deficiency or lack of lactase, the digestive enzyme responsible for the breakdown of lactose into glucose and galactose in the digestive tract, causes lactose intolerance. There are three main forms of lactose intolerance which are congenital, primary acquired, and secondary acquired. Some areas of importance in understanding lactose intolerance are its chemical background, symptoms, diagnosis, and treatment.

Treatment of lactose intolerance has become a new technology in the manufacturing of dairy products. Our increasing awareness of this problem has sparked a surge in the development of dairy products, which have been altered in such a way as to facilitate the breakdown of lactose by the human digestive tract. Such products include Lactaid, Ensure, and Isocal, just to name a few. This new technology in the manufacturing of dairy products has enabled people, who had been unable to digest lactose; to continue to enjoy the wonderful products produced by the dairy industry.

SAD2 Can milk-fat fight cancer? J.L. Lannes*, *Louisiana State University, Baton Rouge.*

Cancer is a leading cause of death each year among Americans. Considerable progress has been made in fighting this disease, but treatments are still not as effective as once hoped. The effort in conquering cancer has shifted from treatment to prevention. Research has shown that nutrition can play a vital role in cancer prevention. Some foods cause cancer to develop and spread, while others help to prevent and even combat cancer development. Recent research indicates that milk fat contains potential anticarcinogenic compounds, including conjugated linoleic acid (CLA), sphingomyelin, and butyric acid. CLA has been shown to inhibit proliferation of human malignant melanomas and colorectal, breast and lung cancer cell lines. Sphingomyelin, through its biologically active metabolites, ceramide and sphingosine, participates in three major antiproliferative pathways of cell regulation: inhibition of cell growth, induction of cell differentiation and induction of apoptosis. These pathways are believed to suppress oncogenesis. Butyric acid also offers promising anticarcinogenic effects as a potent inhibitor of proliferation and inducer of differentiation and apoptosis in a number of cancer cell lines. The

results obtained from research appear promising, but there is still much to be learned. Research continues to determine what levels of these compounds are necessary to achieve the desired effects and at what stage of life these levels need to be introduced. The dairy food industry is also working closely with the animal science industry to try to increase these compounds on an individual animal level.

SAD3 Lacticin 3147: a new approach to pathogen control. D. W. Koontz*, *The Pennsylvania State University, University Park.*

Bacteriocins represent a new approach to control growth of pathogens without using antibiotics, therefore reducing the risk of antibiotic residues in our food system. One bacteriocin attracting interest worldwide is Lacticin 3147. This natural inhibitory agent is produced by a subspecies of the *Lactococcus lactis* bacteria. Lacticin 3147 has been shown by Irish scientists to inhibit *Listeria* growth in cottage cheese. In one specific case it lowered a certain *Listeria* strain by 99.9%. Because it reduces the growth of organisms involved in the spoilage of cheese, it allows for elevated ripening temperatures with faster aroma and flavor development. One research study in Ireland found that using Lacticin 3147 could increase ripening temperatures from 7 to 12 ° C, which can mean reduced cost to the manufacturer and increased quality and value to the consumer. Lacticin 3147 may have uses in other foods such as meat, eggs, and additional dairy products that are prone to high levels of *Listeria*. An additional study found Lacticin 3147 was effective in controlling some types of mastitis caused by gram-positive bacteria. The end result of Lacticin 3147 may be reduced antibiotic residue risk in the food system and increased value to the producer, processor, and consumer. However, use of bacteriocins in the food industry should not replace proper handling and hygiene practices.

Keywords: bacteriocin, Lacticin 3147

SAD4 Salmonella: Are dairy products a concern for foodborne illness?. M. Miller*, *University of Kentucky, Lexington.*

Foodborne illness is a general concern with all food products. *Salmonella* Typhimurium DT104 has caused illness in humans and animals in Europe, but this phage type of *Salmonella* has emerged as an increasing health concern for people in the United States. Concern in

the dairy industry has focussed on the risks associated with consumption of products that are made from unpasteurized milk. Some Mexican-style soft cheeses made from this unpasteurized milk have caused outbreaks of salmonellosis in the Hispanic population. Another outbreak occurred when a farm family consumed raw milk and had contact with sick dairy cattle. *Salmonella* Typhimurium DT104 is resistant to the antimicrobial agents, ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline. Antibiotic resistance causes the greatest con-

cern at this time. This resistance may allow cattle or humans infected with DT104 to be unresponsive to therapy and would increase the risk of serious illness. Prevention is a key to reducing the risk of foodborne illness. Improved farm animal hygiene would help reduce incidence of salmonellosis in cattle and reduce milk contamination. Consumption of raw milk products must be discouraged. Post-pasteurization contamination can be prevented by strict adherence to HACCP programs in the dairy plant.

DAIRY PRODUCTION UNDERGRADUATE PAPER PRESENTATIONS

SAD5 Feeding and management practices for the transition dairy cow. J.D. Brixey*, *California Polytechnic State University, Dairy Science Department, San Luis Obispo.*

Feeding and management practices during the transition period (last three weeks before parturition to three weeks post partum) influences a cow's health, reproduction and potential milk yield. Failure to provide a well designed transition program may lead to the reduction of 10 to 20 pounds of peak milk production in the subsequent lactation. Increased health disorders (milk fever, ketosis, and fat cow syndrome) may result in declining revenues resulting in economic losses of up to \$334/cow/year. During this period, the dry cow is routinely fed a diet relatively high in fiber and low in protein. Upon calving, the lactation cow is fed a ration relatively low in fiber and high in protein, carbohydrates, minerals and vitamins. Improper feeding can prevent the cow from meeting her nutrient requirements, reduce rumen microorganism efficiency and alter rumen pH resulting in decreased milk production and an increase in metabolic disorders. Meeting nutritional needs of the cow during the transition period is challenging with decreasing dry matter intake prior to parturition. Addition of anionic salts and proper dry cow diets has assisted in reducing the early metabolic challenges of lactation. Fresh cow feeding programs should be designed to provide adequate protein and fiber, while meeting energy demands. Feeding and management practices are an important issue within dairy herds today, and careful consideration must be used to determine the best strategy for each individual dairy producer.

SAD6 Efficacy of an *Escherichia coli* J5 bacterin in the prevention of coliform mastitis in dairy cattle. M.L. Telfer*, *University of Wisconsin, River Falls.*

The most common disease facing the dairyman today is mastitis. As producers continue to improve the control of contagious *Staphylococci* and *Streptococci* infections, mastitis caused by environmental agents like *Escherichia coli* have increased. In fact, well managed herds with somatic cell counts below 200,000 may actually be more susceptible to the disease. It is estimated that as much as 40% of all clinical mastitis is caused by environmental bacteria. These bacteria can be picked up in places like bedding, lofting areas, and standing water. This is why environmental mastitis is nearly impossible to eliminate. The best treatment for this type of mastitis is prevention.

Developed and approved in the 1980's, *Escherichia coli* J5 Bacterin vaccines have been proven to effectively reduce the incidence and severity of clinical mastitis in multiparous cows. The J5 vaccine is made from the cell walls of specific *Escherichia coli* bacteria, which effectively induce an immune response, thereby reducing a vaccinated animal's risk of contracting coliform mastitis by up to 80%. There have been many field investigations designed to measure the *Escherichia coli* J5 Bacterin's effectiveness in preventing coliform mastitis in dairy cattle.

SAD7 Uncommon problems with common pests. I.A. Norris, *Louisiana State University, Baton Rouge.*

Leptospirosis, anaplasmosis, rabies, and mastitis are only a few of the many diseases that can cause problems in dairy cattle. While these diseases are different in their effects on the animals, they all are similar in that they can be introduced to the dairy farm by everyday visitors and residents on the premises. Insects, rodents, wild animals, and dogs are among the most common of these disease carrying pests. Insects are not only annoying to dairy cattle but are also capable of transmitting disease-causing organisms to the animals on the farm. Rodents may act as vectors for disease by serving as intermediate hosts for internal and external parasites. Other forms of wildlife, especially birds, are also known to transmit numerous diseases to dairy cattle. While rodents, insects, and wild animals are commonly thought of as pests,

dogs typically are not considered as such. However, dogs can pose potential threats to the health and productivity of the dairy herd because they are known carriers of several disease causing organisms. While vaccines are an important component of preventive medicine in dairy herd health programs, pest management practices are equally important in the control of parasites and disease.

SAD8 Nutritional considerations for the close-up dry cow. S. Oak*, *University of Kentucky, Lexington.*

Dry cows should be managed as two separate groups to accommodate the changes seen in the close-up dry cow during the last twenty-one days of the dry period. As calving time approaches, dry matter intake (DMI) may decrease at the same time as nutrient needs are increasing. A properly implemented close-up dry cow program can help transition the cow back into the milking herd by improving DMI after calving, preparing the cow's rumen for a higher concentrate diet, minimizing metabolic disorders, and improving immune status to decrease health problems. Some of the nutritional approaches used with close-up dry cows include increasing the energy density of the diet, including forages and other feedstuffs similar to those fed to the milking herd, adjusting the amounts of trace minerals and vitamins in the diet, and considering macro-mineral adjustments (dietary cation-anion difference). Dry cows with a good close-up dry cow program will reach higher peak production, produce more milk in that lactation, and potentially make more profit for the producer.

SAD9 Effective cow-side antibiotic testing in milk. J. M. Middour, *The Pennsylvania State University, University Park.*

Because of consumer allergies to antibiotic residues and the interference with certain dairy product manufacturing, one goal of dairy producers is to prevent antibiotic contamination in raw milk. Improper use of antibiotics in the control of mastitis is the major source of antibiotic residues in the milk supply. When used correctly, the cow-side antibiotic test kit is an important management tool to prevent antibiotic residues. Sischo (J. Dairy Sci. 79:1065-1073) stated that these tests have not been objectively evaluated for individual cows. Therefore, sampling individual cows may result in false-positives, which lead to producers discarding acceptable milk based on regular withdrawal times. A study in California found that four out of five commercially available B-lactam (penicillin and its derivatives) antibiotic detection kits yielded false positive results in milk from individual cows. In addition, the detection limits vary from test to test. The Milk and Dairy Beef Quality Assurance Program (MD-BQAP) is designed to eliminate antibiotic residues in consumers' milk. The MDBQAP producer manual suggests cow-side antibiotic testing become routine to protect a producer from accidentally contaminating milk with antibiotics. If proper recommendations and guidelines are followed and the limitations of these tests are recognized, the benefits will greatly outweigh the drawbacks. Antibiotic test kits are valuable tools in maintaining a safe supply of dairy products to consumers.

Key Words: antibiotic test, drug residues

SAD10 The effects of bovine somatotropin on dairy cattle. L. Wright*, *Virginia Tech, Blacksburg.*

The use of recombinant bovine somatotropin (bST) in dairy cattle has become a profitable management tool for many dairy farmers across the United States. Studies have shown that injecting cows with bST nine weeks after calving can increase milk production 5 to 15 pounds a day. Therefore this tool has become a widely used practice for attaining more milk from the cow after she has reached peak production. Some people however feel that there are negative side effects to cows that receive

bST injections, such as an increased chance of mastitis and an increase in reproduction problems. In my presentation I will address the effects of bST on milk production, body weight (BW), feed efficiency, somatic cell count (SCC), and days in milk.

A study by Cornell University done on 80,000 cows over 8 years showed that by using bST on 100% of all applicable cows an increase of 894kg of milk, 27kg of fat, and 31kg of protein could be expected in a 305 day lactation. This study also showed that bST improved persistency of the lactation, while SCC were just slightly higher for those herds using bST. The research also showed that days in milk and average age of animal were not affected by the use of bST during the lactation.

The University of Arizona did a study to determine if the use of bST on lactating dairy cows had any effect if used in consecutive lactations. In this research groups of cows were injected with bST every two weeks for a varying number of consecutive lactations, while the control group did not receive a bST injection. When comparing the control group to the group of cows that received bST for four lactations, the group that received bST out produced the control group by 14%, and gained 37% more body weight than the controls. Therefore previous bST injections had no negative effects on milk yield in subsequent years. These researchers also stated that bST increases milk production by increasing the feed efficiency of the animal.

ORIGINAL RESEARCH/INDEPENDENT STUDY PAPER PRESENTATIONS

SAD12 Garlic as a nutritional adjunct in cheese. C. A. Boenke, J. P. Istre*, J. Istre, A. B. Nichols, and D. T. Do, *Louisiana State University, Baton Rouge.*

Queso Blanco style cheeses were manufactured using balsamic vinegar, red wine vinegar, and garlic. Treatments included cheese made with balsamic vinegar and garlic, balsamic vinegar without garlic, red wine vinegar with garlic, and red wine vinegar without garlic. Samples were analyzed for pH, total solids, fat content, and nitrogen content. Gel electrophoresis was also run on each treatment to compare protein fractions in the cheese. No significant differences were detected in the pH and total solids content between samples. A consumer panel scored the cheeses for texture, taste, overall liking, garlic flavor, and purchase preference. Significant differences were detected among each of these variables ($p < .05$). Cheese manufactured with red wine vinegar and garlic had the highest mean values for texture, taste, and overall liking. Consumers rated this cheese as having an acceptable garlic flavor and indicated purchase tendency if it were commercially available.

SAD13 FlyCracker as a natural house and stable fly larvae control: Duration of effectiveness as a larvicide. S.E. Bedgar*¹, T.M. Moreland², D.L. Owings³, and J. Saunders⁴, ¹University of Maryland, College Park, ²University of Maryland, Agriculture Experiment Station, ³Virginia/Maryland Regional School of Veterinary Medicine, ⁴Biospherics Inc.

Two experiments were conducted to evaluate the potency and frequency of application of FlyCracker (citric acid developed by Biospherics Inc.) as a larvicide when used in granular form in animal bedding. In the first experiment, FlyCracker was applied at rates of 0, 15, and 30 grams per 26.4 square cm (1 square foot) of bedding area. Using a shaker container, FlyCracker was sprinkled around the edges of calf hutches and pen pack bedding. Sample areas were 13 cm W x 13 cm L x 4.5 cm D (Williams et al 1980). Larvae were counted to evaluate concentrations of flies and percent control. Samples were collected every three to four days along the treatment areas. The second experiment used twenty 1.5 m x 1.5 m (4.5' x 4.5') calf pens bedded with roughly 25% sawdust and 75% straw to maintain a bedding of more than 60% dry matter. The pens were allowed to develop adequate organic matter and more than 100 larvae per sample to assure an optimal fly breeding environment and ample larvae infestation. Using a calibrated shaker container, FlyCracker was applied at a rate of 25 grams per 26.4 square cm (1 square foot). Treatments were made every seven days and samples were collected weekly. These experiments demonstrated FlyCracker to be a completely effective larvicide for fly control in bedding with dry matter of greater than sixty percent, when applied at the rate of 25 grams per 26.4 square cm (1 square foot) at 7 day intervals.

In conclusion bST is a very useful tool for dairy farmers today. If managed correctly it will increase milk production, and feed efficiency, with little effect on a farm's reproductive efficiency and SCC.

SAD11 Retained fetal membranes in cattle: causes and treatments. B. MacKie*, *Washington State University, Pullman.*

The assurance of maximal milk production is accomplished through a successful pregnancy that results in an offspring. This cycle is repeated every year when a calf is born. Effective uterine involution and expulsion of fetal membranes must take place in order for a cow to successfully achieve a subsequent pregnancy. Producers are faced with the predicament of understanding causes and treatments of retained fetal membranes. Treatments range from exogenous hormone therapy, manual removal of the membranes or waiting for natural expulsion. It has been determined that the presence of retained fetal membranes in the reproductive tract increases the occurrence of uterine infections and secondary metabolic problems such as hypocalcemia or ovarian cysts. Much of the research is inconsistent, however there is an understanding that the preferred method of treatment requires two administrations of exogenous hormones, either two doses of prostaglandin F2a or gonadotropin releasing hormone and prostaglandin F2a. The causes and treatments of retained fetal membranes will be reviewed from existing research.

SAD14 Processing method to improve the aesthetic quality of skim milk. C.M. Pinto and S.K. Sharma*, *Cornell University, Ithaca, NY.*

The skim milk consumption trend is increasing to meet the nutritional demand and to reduce the fat calorie intake among a large section of the US population. However, the lack of quality attributes such as color, appearance and texture/ mouthfeel are of major concerns to the consumers and to the dairy industry. Therefore, the objective of this research work was to explore processing methods to improve the aesthetic quality of skim milk for its overall acceptance.

Whey protein isolates (WPI) in the concentrations ranging from 0.5 to 2.5% and various gums such as xanthan, carageenan and guar gum (0.05 to 0.15%) were mixed with skim milk, and the mixture was heated at different temperatures (80 to 90°C) and time (5 to 15 min) combinations to obtain an acceptable quality. The quality of the resulting product was evaluated in terms of color parameters (L, a & b) using Macbeth Color Eye spectrophotometer, apparent viscosity using Hake viscometer and sensory characteristics such as color, appearance, texture/ mouthfeel, aroma and flavor, and overall acceptance by sensory panelists on a hedonic scale.

Heating skim milk at 90°C for 10 min was most appropriate to improve the product color. Adding WPI concentration higher than 1.5% and gums higher than 0.1% caused the product to form gel during overnight storage at refrigeration temperature (5°C). It was observed that skim milk containing 1.5% WPI with or without 0.05% xanthan gum improved the appearance, color and texture/ mouthfeel, and its flavor & aroma was not significantly different ($P > 0.05$) from the control sample which was heated under the same conditions. The color parameter such as 'L' value of heated skim milk containing WPI was significantly higher ($P < 0.05$) than the control sample and it was very close to the value of milk containing 2% fat ($P > 0.05$). The viscosity of skim milk containing 0.05% xanthan gum was significantly higher ($P < 0.05$) than skim milk containing 1.5% WPI alone, whole milk sample and 2% fat milk sample. Whereas the viscosity of skim milk containing 1.5% WPI was not significantly different from whole milk samples. It was concluded that aesthetic quality of skim milk could be easily improved by adding 1.5% WPI and heating to 90°C for 10 min.

SAD15 Comparison of bovine serum (LifeLine) versus colostrum on the efficiency of IgG absorption and attainment of passive immunity in newborn dairy bull calves. B. Branek*¹, M. Cattell², and J. Quigley³, ¹Chadron State College; Chadron, NE, ²Dairy Research and Technology; Loveland, CO, ³APC, Inc.; Ames, IA.

The objective of this study was to compare the efficacy of two supplemental spray-dried bovine serum products versus colostrum on the

attainment of passive immunity in newborn dairy bull calves. Seventy-five (n=25/treatment) newborn Holstein calves were collected at birth and prior to consumption of dam's colostrum. The calves were assigned to one of three treatments using a predetermined randomized allocation schedule. Each of the treatments were administered in a volume of two liters per feeding. Treatments were given within 2h of birth and again within 12h of administration of the first treatment. Any volume not consumed was recorded and administered via esophageal tube. Calf birth weights were also recorded. Blood samples were collected at birth (prior to administration of the first treatment), and at 24+/-1h after birth. Serum was harvested, split and frozen in duplicate for later IgG analysis. The study was divided into two blocks, with the second block beginning with the use of material from a second shipment. No calves that received maternal colostrum were tubed, and there was little difference in IgG levels at 24h in the two blocks (10.47 and 10.73 g/L respectively). Calves in this group had an average efficiency of IgG absorption (AEA) of 25% and 27% for the two blocks respectively. One half of the calves enrolled in the second group (LifeLine at 45g/dose) were tubed in the first block, while 12.5% were tubed in the second block. IgG levels at 24h among these calves were 4.70 and 6.44g/L respectively. The AEA for this group was 19% and 27% respectively. The final group was given LifeLine at 50g/dose. 60% of calves in the first block and 10% in the second block were tubed. 24h IgG levels among these calves were 3.37 and 6.80g/L for the two blocks respectively. Their AEA were 12% and 25% respectively.

SAD16 Using process control to monitor bulk tank somatic cell count. D. A. Schreiner* and P. L. Ruegg, *University of Wisconsin, Madison.*

Bulk tank somatic cell count (BTSCC) has become an important component of monitoring milk quality. Differentiating "real change" in SCC from normal variation can be difficult. Process control charts are a method used to differentiate natural variation from outside influence such as increased mastitis. The objective of this study was to apply concepts of process control analysis to BTSCC. The four basic questions investigated in this study were: 1) How many data points needed to be used to determine significant variation on each farm? 2) What was the sensitivity of this method of analysis? 3) Can a rolling average be used in order to see trends? 4) Could SCC signals be explained by environmental changes or changes in parlor procedure? Three WI dairy herds participated in the study between June and August of 1999. Parlor procedures and mastitis data were recorded on each farm, and BTSCC's were obtained from the processor. Holding pen temperature and humidity was collected on farm every 30 minutes. Signals were detected by following the nine rules detected by Statistix analytical software. Signals could be either single point signals or trend signals. Single point signals occurred when one point exceeded a predetermined interval surrounding the mean BTSCC. Trend signals were detected by a gradual consistent change in the process over a series of data points. A 20 or 30 data point set was effective in detecting the desirable number of signals on these three farms, but was dependent on the amount of variation occurring on each farm and the desired sensitivity. There was no significant relationship between farm management data and the occurrence of a signal. This may have been due to the trend signals overlap into weeks that did not contain signals. The rolling average method detected an equivalent number of signals as the standard method of analysis. In addition, the rolling average method had the ability to detect gradual trends that the tests would not detect, due to the slight changes over broad periods of time.

SAD17 Effectiveness of tempering barley with yeast culture and fibrolytic enzymes for lactating dairy cows. D.B. Carlson*, J.W. Schroeder, M.S. Laubach, D.E. Schimek, W.L. Keller, and C.S. Park, *North Dakota State University, Fargo.*

The objectives of this research were to determine if tempering barley and adding a combination of a live yeast culture and a fungal extract preparation promote enhanced feed utilization and alter the yield or composition of milk from cows fed barley-based diets. Barley was tempered for 24 h at 20% moisture and rolled before adding to completely blended diets. Twenty-four primiparous and multiparous Holstein cows averaging 575 kg body weight and 46 d in lactation were stratified by age, days in milk, and milk yield and randomly assigned to one of four isonitrogenous, isocaloric diets: 1) tempered rolled barley (TRB-W) and 2) dry rolled barley (DRB-W) both with additives (a yeast culture and

a fibrolytic enzyme, 9 and 15 g/d per cow, respectively) and 3) tempered rolled barley (TRB-O) and 4) dry rolled barley (DRB-O) without additives. Cows were offered the respective diets twice a day in Calan gates for nine wk. A repeated measures analysis was conducted for a fixed model with three, 21-d collection periods. Substituting tempered for dry rolled barley did not alter dry matter intake (DMI), milk yield, or body condition. However, cows fed diets with the combination of additives had greater milk yield ($P < 0.05$) during the first 21 d and lower ($P < 0.002$) DMI when compared to those cows fed diets without the additives during the last 21 d on these diets. Cows in the TRB-O and TRB-W groups had lower rumen ammonia ($P < 0.007$) and milk urea nitrogen (MUN) ($P < 0.07$) during the first 21-d period, while cows fed DRB-W and TRB-W diets had lower ($P < 0.01$) rumen ammonia and lower MUN ($P < 0.03$) during the last 21 d collection period. No difference existed among diets during period 2. An interaction existed for milk lactose ($P < 0.004$) and SNF ($P < 0.02$) between barley form and inclusion of additives. No differences existed among treatments for fat-corrected milk yield, but diets supplemented with the additives had greater energy use ($P < 0.008$) and protein ($P < 0.001$) efficiency, especially when used in combination with barley that was tempered versus dry rolled prior to feeding.

SAD18 Effect of estradiol cypionate in early postpartum dairy cattle. J. M. Haughian*, R. Sartori, J. N. Guenther, A. Gumen, and M. C. Wiltbank, *University of Wisconsin, Madison.*

Treatment with the long-acting estradiol-17 β , estradiol cypionate (ECP), is frequently used to treat uterine problems in early postpartum cattle; however, there are concerns that ECP may increase ovarian disorders, such as follicular cysts. This study characterized the effects of ECP on follicular growth, ovulation, and reproductive hormone patterns in dairy cattle. Lactating Holsteins received 25 mg ECP (ECP; n=17) or placebo (CON; n=16) on d 7 postpartum. Data were collected from d 5-90 of lactation and included daily serum samples and daily (d 5-30) or every other day (d 30-90) ultrasound examinations of follicular and luteal activity. After d 90, all animals were bred using the Ovsynch protocol (GnRH-7d-PGF2 α -2d-GnRH-1d-AI). The ECP group had elevated ($p < .05$) serum estradiol on the day after treatment (ECP: 27.1 \pm 3.6 pg/ml; CON: 6.7 \pm 1.1 pg/ml) until 11 d post-treatment (ECP: 12.4 \pm 1.2 pg/ml; CON: 8.9 \pm 1.2 pg/ml). Detection of the first postpartum follicle > 10 mm was later ($p < .01$) in ECP (29.1 \pm 7.1d) than CON (12.4 \pm 3.1d). Time to first ovulation (from ultrasonography and progesterone) was delayed ($p < .01$) in ECP (55.6 \pm 4.1d) vs. CON (37.9 \pm 4.9d). Mean size of the first ovulatory follicle was not different ($p > .10$) between ECP (14.6 \pm 3.5mm) and CON (15.7 \pm 3.9mm). Ovulation prior to 30 d in milk occurred in 38% of CON but in none of the ECP cows ($p < .01$). A total of 69% of CON cows had ovulated at least once by 50 d; whereas, only 35% of ECP cows ($p < .10$). Nevertheless, when cows were evaluated at the time of Ovsynch (90 d) regular estrous cycles were found in only 50% of CON but in 88% of ECP cows ($p < .05$). The reasons for lack of cyclicity were no ovulation by 90 d postpartum (3 CON, 1 ECP), ovulation followed by anovulatory follicular waves (3 CON, 1 ECP), and persistent corpus luteum (>50d; 2 CON). Only 3 cows developed follicular cysts (follicle > 25mm; 2 CON, 1 ECP). Thus, although treatment with ECP on day 7 postpartum delayed the time to first ovulation, it did not induce follicular cysts, and it decreased cows with reproductive problems at 90 d postpartum.

SAD19 Changes in amino acid composition of milk replacer fed bull calves from birth to 105 kg. J.M. Kelsey*, M.C. Diaz, D.A. Ross, and M.E. Van Amburgh, *Cornell University, Ithaca, NY.*

Sixty calves were assigned to a comparative slaughter study to determine energy, protein and amino acid (AA) composition from birth to 105 kg bodyweight (BW). Six calves were slaughtered before reaching 24h of age and served as a baseline for a comparison of potential changes. Calves were fed a milk replacer that contained approximately 30% protein, 20% fat and 4.6 Mcals/kg metabolizable energy, three times per day to achieve a target rate of liveweight gain. Calves were assigned to three treatments of 500 (Low), 950 (Medium), and 1400 (High) g/d rates of gain and three slaughter points at 65, 85 and 105 kg BW. Actual rates of BW gain were 597 (Low), 1000 (Medium) and 1202 (High) g/d. At slaughter, tissues were split into four fractions: carcass, organs, liver and head, hide, feet and tail (HHFT), freeze dried, defatted and hydrolyzed in either 6 N HCl, HCl after performic acid oxidation

or barium hydroxide for AA analysis. Twelve of these calves were randomly chosen for AA analysis, six each from Low and High treatments at slaughter weights 65 kg (three) and 105 kg (three). The AA composition of the separate fractions (g amino acid/100g protein) was compared among the baseline and treatment animals. There were differences ($P < 0.05$) in the carcass AA composition between baseline and treatment calves in the following amino acids: Asp, Thr, Ser, Glu, Pro, Ile, Leu, Tyr, Phe, His and Arg. In the organ fraction Glu and Val differed ($P <$

0.05). In the liver fraction Glu, Val, Ile, Leu, Phe, His and Arg differed ($P < 0.05$). There were no differences in AA composition in the HHFT fraction. There is a peak that represents the ammonia content of the tissues and was eluted with the AA's. In all tissues except carcass, there were large ($P < 0.05$) differences in the ammonia concentration between baseline and treatment calves. These differences in ammonia might possibly be attributed to the shift in energy sources the calf experiences after birth.