

**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\*<sup>1</sup> and P.W.J. van Boekel<sup>2</sup>, <sup>1</sup>*Wageningen University, The Netherlands*, <sup>2</sup>*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\*<sup>1</sup> and J. Morrow-Tesch<sup>2</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*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\*<sup>1</sup>,  
<sup>1</sup>*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- $\alpha$  (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\*<sup>1</sup>, J. Goff<sup>1</sup>, and H. Tyler<sup>2</sup>,  
<sup>1</sup>*National Animal Disease Center, USDA-ARS,* <sup>2</sup>*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\*<sup>1</sup>, <sup>1</sup>*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\*<sup>1</sup>, <sup>1</sup>University 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\*<sup>1</sup> and E. Kolver<sup>2</sup>, <sup>1</sup>Livestock Improvement, Hamilton, New Zealand, <sup>2</sup>Dairy 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\*<sup>1</sup>, J. A. M. Van Arendonk<sup>1</sup>, and J. A. Woolliams<sup>2</sup>, <sup>1</sup>*Animal Breeding and Genetics Group, Wageningen University, The Netherlands*, <sup>2</sup>*Roslin Institute (Edinburgh), Roslin, Midlothian, UK.*

In evaluations of combined crossbred purebred selection (CCPS) schemes, the effect of the rate of inbreeding ( $\Delta F$ ) 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  $\Delta F$ . In a deterministic study, rates of genetic gain ( $\Delta G$ ) 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  $\Delta F$  by a factor 2.14. To achieve the same  $\Delta F$ , 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  $\Delta G$  from both selection strategies at the same  $\Delta F$ . When compared at the same  $\Delta F$ , CCPS was superior to PLS and the superiority of CCPS was only moderately reduced compared to the situation without a restriction on  $\Delta F$ . For example, for  $h^2 = 0.4$ ,  $r_{pc} = 0.7$  and  $\Delta F < 1\%$ , using CCPS instead of PLS increased  $\Delta G$  by 15%, whereas in the absence of a restriction  $\Delta G$  increased by 20%. Increasing the number of parents reduced  $\Delta F$  substantially, but only moderately reduced  $\Delta G$ . 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  $\Delta F$  from 0.036 to 0.011 and  $\Delta G$  from 0.394 to 0.330. This study shows that the long-term genetic contribution theory can be used to balance  $\Delta F$  and  $\Delta G$  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\*<sup>1</sup> and J. A. Woolliams<sup>2</sup>, <sup>1</sup>*Animal Breeding and Genetics Group, Wageningen University*, <sup>2</sup>*Roslin Institute(Edinburgh), Roslin, Midlothian, UK.*

A general theory to predict rates of inbreeding ( $\Delta F$ ) in selected populations has recently been developed. The theory states that  $\Delta F$  is proportional to the sum of squared expected long-term genetic contributions. Here we will develop predictions of  $\Delta F$  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  $\Delta F$  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  $\Delta F$  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  $\Delta F$  from 0.0184 to 0.0210. This shows that, with respect to  $\Delta F$ , 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\*<sup>1</sup>, T. Druet<sup>2</sup>, I. Misztal<sup>1</sup>, and K. Bertrand<sup>1</sup>, <sup>1</sup>*The University of Georgia, Athens*, <sup>2</sup>*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\*<sup>1</sup>, A. V. Capuco<sup>1</sup>, A. Contreras<sup>2</sup>, and J. C. Marco<sup>3</sup>, <sup>1</sup>USDA-ARS, Beltsville, MD, <sup>2</sup>Universidad de Murcia, Murcia, Spain, <sup>3</sup>Maria 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 10<sup>6</sup>/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 10<sup>3</sup>/ml. Cell counts for sheep are similar to cows and range from 10 to 200 x 10<sup>3</sup>/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 10<sup>3</sup>/ml while goat milk averages 150 x 10<sup>3</sup>/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 10<sup>3</sup>/ml during the first 3 months of lactation and progressively increase to > 1,000 x 10<sup>3</sup>/ml during the latter months of lactation. For sheep, counts are highest during the first few weeks of lactation (500 x 10<sup>3</sup>/ml) and decrease to 30 x 10<sup>3</sup>/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\*<sup>1</sup> and H.M. Farrell, Jr.<sup>2</sup>, <sup>1</sup>Prairie View A&M University, CARC, Prairie View, TX 77446, <sup>2</sup>USDA, 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/T<sub>2</sub>) 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  $\alpha_{s1}$ - to  $\beta$ -casein. Variants of  $\alpha_{s1}$ -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  $\alpha_{s1}$ -casein retain an open, highly hydrated structure, in comparison with the rennin-coagulated caprine casein micelles containing high  $\alpha_{s1}$ -casein. Second virial coefficients (B<sub>o</sub> values) derived from oxygen-17 NMR data suggest that the native caprine casein micelles containing high  $\alpha_{s1}$ -casein exhibit strong interactions, whereas the native caprine casein micelles containing low  $\alpha_{s1}$ -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\*<sup>1</sup>, P.H. Dixon<sup>1</sup>, Y.W. Park<sup>2</sup>, J.A. Gilmore<sup>1</sup>, and P.S. Kindstedt<sup>1</sup>, <sup>1</sup>Northeast Dairy Foods Research Center, University of Vermont, Burlington, <sup>2</sup>Agricultural 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 again 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 (r<sup>2</sup>=0.94). SDS-PAGE analysis showed that the goat's milk contained very little  $\alpha$ 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\*<sup>1</sup>, <sup>1</sup>*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  $\beta$ -lactoglobulin, about the same proportion of  $\alpha$ -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\*<sup>1</sup>, <sup>1</sup>*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  $\alpha$ -lactalbumin,  $\beta$ -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  $\alpha$ -lactalbumin and human IGF-I in porcine mammary gland: effects on lactation and piglet growth and development.** S.M. Donovan\*<sup>1</sup>, M.H. Monaco<sup>1</sup>, G.T. Bleck<sup>3</sup>, J.B. Cook<sup>2</sup>, M. Noble<sup>2</sup>, W.L. Hurley<sup>2</sup>, and M.B. Wheeler<sup>2</sup>, <sup>1</sup>*Dept Food Sci & Human Nutr.*, <sup>2</sup>*Dept Animal Sciences, University of Illinois, Urbana.*, <sup>3</sup>*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  $\alpha$ -lactalbumin ( $\alpha$ -LAC; two lines) and human IGF-I (four lines).  $\alpha$ -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  $\alpha$ -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  $\alpha$ -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  $\alpha$ -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 ( $\sim 1$  mg/L). Milk yield may also be enhanced in IGF-I transgenic sows on d 3 ( $5.4 \pm 1.0$  kg,  $n = 4$ ) vs. nontransgenic sows ( $4.1 \pm 1.2$  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\*<sup>1</sup>, <sup>1</sup>Lawson 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  $\alpha$ -lactalbumin, but monomeric, native  $\alpha$ -lactalbumin had no bactericidal effect. Native  $\alpha$ -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 Nauth<sup>1</sup>, <sup>1</sup>*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\*<sup>1</sup> and K. Kaylegian<sup>2</sup>, <sup>1</sup>*Virginia Polytechnic Institute and State University, Blacksburg,* <sup>2</sup>*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 $\alpha$ ). 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\*<sup>1</sup>, J.E. Vallimont<sup>2</sup>, G.A. Varga<sup>2</sup>, and Y. Aharoni<sup>3</sup>, <sup>1</sup>*Hebrew University of Jerusalem, Rehovot, Israel*, <sup>2</sup>*Pennsylvania State University, University Park*, <sup>3</sup>*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 ( $BF = 1.39(\text{FCD}) - 43$ ;  $R^2 = 0.73$ ) and between calculated BP and BW ( $BP = 0.12(\text{BW}) + 12$ ;  $R^2 = 0.99$ ) were shown. Fat cell diameter and BCS were related with a  $R^2$  of 0.45 ( $\text{FCD} = 19.57(\text{BCS}) + 40$ ). 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\*<sup>1</sup>, K.W. Koelkebeck<sup>2</sup>, R.L. Adams<sup>3</sup>, C.J. Flegal<sup>4</sup>, A.H. Cantor<sup>1</sup>, F.V. Muir<sup>5</sup>, M.A. Latour<sup>3</sup>, C.M. Parsons<sup>2</sup>, M.W. Orth<sup>4</sup>, and K.D. Roberson<sup>4</sup>. <sup>1</sup>University of Kentucky, Lexington, <sup>2</sup>University of Illinois, Urbana, <sup>3</sup>Purdue University, West Lafayette, IN, <sup>4</sup>Michigan State University, East Lansing, <sup>5</sup>The 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\*<sup>1</sup>,  
<sup>1</sup>North 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\*<sup>1</sup>, D.E. Boardman<sup>1</sup>, M.B. Opperman<sup>1</sup>, J.M. Mattison<sup>1</sup>, and B.R. Eastwood<sup>2</sup>, <sup>1</sup>ADDS Center, <sup>2</sup>USDA-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<sup>®</sup> software is used for creating and searching InfoBases. For publication on a CD, the InfoBase must be "bound," a term Folio<sup>®</sup> 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\*<sup>1</sup>, <sup>1</sup>Penn 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. Klopfenstein<sup>1</sup>, R. Mass<sup>1</sup>, K. Creighton<sup>1</sup>, and T. Patterson<sup>1</sup>, <sup>1</sup>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- $\alpha$ (ACC- $\alpha$ ): gene structure-function relationships. M. T. Travers\* and M. C. Barber, Hannah Research Institute, Ayr, UK.**

ACC- $\alpha$  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- $\alpha$  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- $\alpha$  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- $\alpha$  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- $\alpha$  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\*<sup>1</sup>, G.T. Ooi<sup>2</sup>, M.L. Tremblay<sup>3</sup>, R.P. Rhoads<sup>1</sup>, and I. Ueki<sup>1</sup>, <sup>1</sup>Cornell University, Ithaca, NY, <sup>2</sup>Prince Henry's Institute of Medical Research, Clayton, Victoria, Australia, <sup>3</sup>McGill 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<sup>-/-</sup> and p27<sup>+/-</sup> 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<sup>+/-</sup> mice. Eighteen 4-month-old, female p27<sup>+/-</sup> 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\*<sup>1</sup>, R. M. Akers<sup>2</sup>, S. E. Ellis<sup>3</sup>, and D. L. Wood<sup>1</sup>, <sup>1</sup>USDA-ARS, Beltsville, MD, <sup>2</sup>Virginia Polytechnic Institute and State University, Blacksburg, <sup>3</sup>Medical 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\*<sup>1</sup>, R.R. Kraeling<sup>1</sup>, and G.B. Rampacek<sup>2</sup>, <sup>1</sup>USDA, ARS, Athens, GA, <sup>2</sup>University 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<sup>\*1</sup>, J.A. Carroll<sup>1</sup>, K.J. Touchette<sup>2</sup>, G.L. Allee<sup>2</sup>, and R.L. Matteri<sup>1</sup>, <sup>1</sup>USDA Agricultural Research Service Animal Physiology Unit, Columbia, MO, <sup>2</sup>University 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 ( $\alpha$ -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  $\alpha$ -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<sup>\*1</sup>, C. R. Barb<sup>2</sup>, R. R. Kraeling<sup>2</sup>, G. B. Rampacek<sup>3</sup>, J. B. Barrett<sup>2</sup>, and D. H. Keisler<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>ARS-USDA, Athens, GA, <sup>3</sup>University 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)  $\mu$ g/pig UCN or saline (n = 3) in Experiment (Exp) 1 or after iv injection of 5  $\mu$ 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<sup>\*</sup>, 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 $\beta$  (IL-1 $\beta$ ) 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 Na<sub>2</sub>CO<sub>3</sub>) was administered i.p. one hr prior to i.p. injection of 150  $\mu$ 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 $\beta$  mRNA (107  $\pm$  4.1 vs. 92.9  $\pm$  4.7, P = .03), but concurrently decreased 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 $\beta$  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<sup>\*1</sup>, R.M. Slepetic<sup>1</sup>, A.W. Bell<sup>1</sup>, D.J.R. Cherney<sup>1</sup>, M.E. Van Amburgh<sup>1</sup>, and Y.R. Boisclair<sup>1</sup>, <sup>1</sup>Cornell 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<sup>\*1</sup>, D. L. Hancock<sup>1</sup>, M. L. Heiman<sup>2</sup>, J. D. Muegge<sup>1</sup>, J. L. Roth<sup>1</sup>, and D. B. Anderson<sup>1</sup>, <sup>1</sup>Elanco Animal Health, <sup>2</sup>Lilly 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<sup>\*1</sup>, J.D. Ambrose<sup>2</sup>, D.R. Glimm<sup>1</sup>, T.J. Kieffer<sup>1</sup>, and J.J. Kennelly<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, Canada,, <sup>2</sup>Alberta 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<sup>\*1</sup>, W.R. Butler<sup>1</sup>, R.A. Ehrhardt<sup>1</sup>, A.W. Bell<sup>1</sup>, and Y.R. Boisclair<sup>1</sup>, <sup>1</sup>Cornell 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 (R<sup>2</sup>=0.6 for both, P < 0.01), and negatively related to concentration of NEFA (R<sup>2</sup>=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

### 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\*<sup>1</sup>, C.P. Van Tassell<sup>1,2</sup>, and M.S. Ashwell<sup>1</sup>, <sup>1</sup>*Gene Evaluation and Mapping Laboratory*, <sup>2</sup>*Animal 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\*<sup>1</sup>, K. P. McNatty<sup>2</sup>, and G. H. Davis<sup>3</sup>, <sup>1</sup>*AgResearch Molecular Biology Unit, Dunedin, New Zealand*, <sup>2</sup>*AgResearch, Wallaceville Animal Research Centre, Upper Hutt, New Zealand*, <sup>3</sup>*AgResearch, 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\*<sup>1</sup>, <sup>1</sup>*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 though 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\*<sup>1</sup>, <sup>1</sup>Universidad 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  $\alpha$ -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  $\alpha$ -tocopheryl acetate. Following intestinal esterase activity,  $\alpha$ -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  $\alpha$ -tocopherol. Kinetic and chemical analyses indicated that  $\alpha$ -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.  $\alpha$ -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  $\mu\text{g}$   $\alpha$ -tocopherol/g longissimus, which coincides with 3.1  $\mu\text{g}/\text{g}$  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  $\alpha$ -tocopherol content. A serving of 84 g of beef containing 3  $\mu\text{g}$   $\alpha$ -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 D<sub>3</sub> (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  $\leq 3.86$  kg relative to CON and VITE treatments (7.4 d and 9.8 d versus 15.8 d and 11.8 d, respectively). Additional 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  $\geq 3.86$  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 animal 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  $\Delta^9$ -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. Ball<sup>1</sup>, K. Polson<sup>1</sup>, J. Emeny<sup>1</sup>, W. Eyestone<sup>1</sup>, and R. M. Akers\*<sup>2</sup>, <sup>1</sup>*PPL Therapeutics, Inc., Blacksburg,* <sup>2</sup>*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 of 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  $\alpha$ -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\*<sup>1</sup>, <sup>1</sup>*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\*<sup>1,2</sup>, L. K. Christenson<sup>1</sup>, T. A. Molskness<sup>1</sup>, and T. M. Hazzard<sup>1</sup>, <sup>1</sup>*Oregon Regional Primate Research Center, Beaverton,* <sup>2</sup>*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 F<sub>2</sub>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 3βhydroxysteroid dehydrogenase/Δ5,Δ4 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\*<sup>1</sup>, Z. B. Johnson<sup>1</sup>, and J. A. Pennington<sup>2</sup>, <sup>1</sup>*University of Arkansas, Fayetteville,* <sup>2</sup>*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\*<sup>1</sup>, <sup>1</sup>*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\*<sup>1</sup>, L. L. Smith<sup>2</sup>, N. Fattohi<sup>1</sup>, and A. N. Sinha<sup>1</sup>, <sup>1</sup>*Fort Dodge Animal Health, Princeton, N.J.*, <sup>2</sup>*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 $\beta$  (E17 $\beta$ ), 140 mg trenbolone acetate (TBA), or 14 mg E17 $\beta$  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 $\beta$  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 $\beta$  consumed more ( $P = .07$ ) feed during the finishing period but were less ( $P = .05$ ) efficient than steers that had not been implanted with E17 $\beta$  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 $\beta$  were heavier ( $P = .04$ ) upon conclusion of the finishing period and yielded heavier ( $P < .01$ ) carcass weights than those not implanted with E17 $\beta$  previously, partially explaining their greater ( $P = .04$ ) longissimus area. Steers that had received a previous E17 $\beta$  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 $\beta$  implant. The use of E17 $\beta$ -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\*<sup>1</sup>, G.E. Carstens<sup>2</sup>, D.A. Neuendorff<sup>1</sup>, A.W. Lewis<sup>1</sup>, W.J. Wilson<sup>1</sup>, and R.D. Randel<sup>1</sup>, <sup>1</sup>*Texas A&M University, Overton*, <sup>2</sup>*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<sup>\*1</sup>, J. L. Beckett<sup>1</sup>, R. Brandt<sup>2</sup>, and J. Algeo<sup>3</sup>, <sup>1</sup>Cal Poly State University, <sup>2</sup>Hoechst-Roussel Agri-Vet Co., <sup>3</sup>Algeo 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 (E<sub>2</sub>), 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 P<sub>4</sub> in the early feeding phase depresses quality grade in Holstein steers. This depression may be partially attenuated by administration of TBA and E<sub>2</sub> 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 <sub>4</sub> (200)	TBA(120) + E <sub>2</sub> (24)
B	EB(10) + P <sub>4</sub> (100)	None	EB(20) + P <sub>4</sub> (200)	TBA(120) + E <sub>2</sub> (24)
C	EB(10) + P <sub>4</sub> (100)	None	TBA(80) + E <sub>2</sub> (16)	TBA(120) + E <sub>2</sub> (24)
D	TBA(40) + E <sub>2</sub> (8)	None	TBA(80) + E <sub>2</sub> (16)	TBA(120) + E <sub>2</sub> (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 µg/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<sup>\*1</sup>, R.C. Vann<sup>1</sup>, T.D. Pringle<sup>2</sup>, and J.L. Varnadoe<sup>1</sup>, <sup>1</sup>The University of Georgia, Tifton, <sup>2</sup>The 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 cm<sup>2</sup> 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±.11 vs 2.45±.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\*<sup>1</sup>, <sup>1</sup>Pipestone 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\*<sup>1</sup>, U. Tasch<sup>1</sup>, A. Lefcourt<sup>2</sup>, B. Erez<sup>3</sup>, and R. Dyer<sup>3</sup>, <sup>1</sup>UMBC, <sup>2</sup>USDA, <sup>3</sup>UMCP.

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<sup>-1</sup>BW) 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\*<sup>1</sup> and J. M. Watts<sup>1</sup>,  
<sup>1</sup>*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\*<sup>1</sup>, <sup>1</sup>*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\*<sup>1</sup>, <sup>1</sup>*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\*<sup>1</sup> and P. S. Kuber<sup>2</sup>, <sup>1</sup>*University of Georgia, Athens,* <sup>2</sup>*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\*<sup>1</sup>, R M Lewis<sup>1</sup>, J E Collins<sup>2</sup>, and G Nieuwhof<sup>3</sup>, <sup>1</sup>SAC, UK, <sup>2</sup>Signet, UK, <sup>3</sup>Meat and Livestock 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 purebred 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 cooperative 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\*<sup>1</sup> and A. Rodiek<sup>2</sup>, <sup>1</sup>University of California, Davis, <sup>2</sup>California 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