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ABSTRACTS 2006 ASAS ADSA Midwest Meeting

March 20–22, 2006

*Author presenting paper

David H. Baker - Amino Acid Symposium

1 Apparent, standardized, and true ileal digestibility of amino acids: What is the difference and practical significance? H. H. Stein*, *South Dakota State University, Brookings.*

Ileal digestibility values for AA may be expressed as apparent (AID), standardized (SID) or true (TID) ileal digestibility values. These terms are used to specify how ileal endogenous AA losses were considered in the measurement of digestibility. The endogenous losses consist of AA that were secreted into the GI-tract by the animal and not digested and reabsorbed before reaching the distal ileum. These losses are divided into the basal losses and the diet-specific losses. The basal endogenous AA losses are the sum of the fasting endogenous AA losses and AA that are secreted in response to the presence of DM in the intestinal tract. These losses are constant across feed ingredients and may be quantified by feeding a N-free diet. The diet-specific endogenous losses of AA are secreted in response to the presence of fiber and(or) anti-nutritional factors in the intestinal tract. These losses vary among different feed ingredients dependent on the concentration of fiber and anti nutritional factors in the ingredient. The AID are calculated if all AA in the ileal output are subtracted from the intake of AA. The net quantities of AA that are absorbed from feeding a specific diet are most accurately estimated by calculating the AID. However, if values for AID are measured in individual feed ingredients, then these values are not always additive when the ingredients are included in mixed diets. The AID may be corrected for the basal endogenous losses of AA which results in the calculation of SID. Values for SID obtained in individual feed ingredients are additive in mixed diets. If the AID values are corrected for both basal and specific endogenous losses, then values for TID are calculated, but reliable procedures to routinely measure specific endogenous losses are not available. Therefore, values for SID should be used in practical feed formulation and when assessing the requirements of AA by the animals. Values for AID may be used to estimate the net absorption of AA from a specific diet. Values for TID are usually not used in practical animal production.

Key Words: Amino acids, Digestibility, Pigs

2 Lysine requirements of neonatal pigs fed manufactured liquid diets. H. Lewis¹, O. Phillips¹, R. Cabrera², R. Boyd³, J. Usry⁴, J. Odle¹, and R. Harrell*¹, ¹*North Carolina State University, Raleigh,* ²*Ralco Nutrition, Marshall, MN,* ³*The Hanor Company, Spring Green, WI,* ⁴*Ajinomoto Heartland, Chicago, IL.*

Sow milk composition is thought to provide the ideal profile of nutrients for the neonatal pig. The increased interest in feeding neonatal pigs liquid diets independent of the sow to improve pig survivability and reduce variation in weaning weights has led to the need of establishing their nutrient requirements. The objective of the current experiment was to define the lysine requirements of pigs from birth to 5 kg BW. Forty one-day old neonatal pigs with an initial BW of 1,631 +/- 35 g were randomly assigned to one of ten dietary treatments ranging from 3.2 to 6.8 g Lys/Mcal GE, dry matter basis. Diets were formulated utilizing whey protein concentrate and casein as protein sources, and reconstituted at 150 g/L. Pigs were initially fed increasing amounts over a 5-d period from 350 to 600 g/kg BW^{-0.75}/d according to the average pig weight across treatments. Thereafter, pigs were fed 600 g/kg BW^{-0.75}/d until they reached a constant BW of 5 kg. The empty body, including blood, was ground and analyzed for chemical composition. The estimated grams of Lys/Mcal of GE to maximize growth rate (271 g/d) and crude protein deposition rate (41.3 g/d) were 5.9 and 5.5, respectively. The estimate represents approximately a 55% increase in g Lys/Mcal of GE compared to sow's milk (3.7 g Lys/Mcal GE). Therefore, manufactured liquid diets formulated to provide approximately 4,300 kcal/kg GE should contain approximately 2.4% lysine to meet the growth requirements of neonatal pigs.

Key Words: Liquid diets, Lysine, Neonatal swine

3 Towards quantification of amino acid needs for body maintenance functions and growth in the pig. C. de Lange*, *University of Guelph, Guelph, ON, Canada.*

Utilization of dietary available amino acid (AA) intake for body protein deposition (PD) in growing pigs reflects a number of interacting and complex physiological and biochemical processes. These processes and their control may be represented mathematically and based on causal relationships for optimizing AA and N utilization in specific groups of pigs. A stochastic and dynamic representation of AA utilization is required to quantify the diminishing marginal efficiency of AA utilization for PD and the impact of nutritional history on compensatory PD. Even though the concept of maintenance may have little relevance to growing animals, it is mathematically convenient to separate available AA needs for processes associated with growth (AA retention with PD, inevitable and preferential AA catabolism) from body maintenance processes that are independent of growth (endogenous AA losses into the gut and from the skin, minimum AA catabolism, use of AA for synthesis of non-protein compounds). Quantitative estimates of these aspects of AA utilization have been generated. Two key aspects of AA utilization that are determined by animal type are the upper limit to PD and minimal body fatness (minimum ratio of body lipid mass to body protein mass; minLP). The concept of minLP is useful to represent the relationship between PD and energy intake and dynamic changes in PD following a period of AA intake restriction. It is suggested that specific aspects of AA utilization require further research, including diet effects on endogenous gut AA losses and associated AA catabolism, the impact of stressors and immune system activation on AA utilization and PD, and the relationships between protein synthesis and PD. Methodology used to establish PD curves in individual pigs should be refined. The mathematical representation of AA utilization for PD is a simplification of reality, but allows us to identify areas where knowledge of AA utilization in the growing pig is weak and provides the best available means to predict the pigs' growth response to different AA intake regimes.

Key Words: Pigs, Nutrition, Amino acids

5 Role of energy and other dietary constituents on the utilization by pigs of free- and protein-bound amino acids. J. F. Patience* and A. D. Beaulieu, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada.*

The interaction between energy and protein is attracting increasing interest in both applied swine nutrition and in more basic approaches to nutrition research. In part, this interest recognizes the fundamental but poorly quantified relationship between the supply of energy in the diet and the utilization of amino acids for either protein synthesis or for other metabolic processes, including glucose metabolism. Additionally, practical diets in North America are changing, and the commercial nutritionist is faced with decisions on the nature, quantity, and source of energy in the diet and its impact on the rate and composition of growth in the immature pig, on reproductive success in the pregnant adult, and

on lactation performance in the nursing sow. The traditional simplicity of corn-soy diets is gradually being displaced by increasing dependence on by-product ingredients. The rationalization of the feed industry means nutritionists are facing varying economics of dietary fat as an energy source as well as increasingly diverse ingredient supply. Growing interest in reducing nutrient excretion as a means of mitigating environmental issues is also changing the expectations of practical pig diets. For example, the implementation of lower protein diets appears to be more successful when the NE system is applied, in comparison to the more traditional (in North America) ME or DE systems. While the NE system offers both theoretical and practical advantages over ME and DE, the benefits are not always observed in commercial practice, with the greatest uncertainty associated with the achievement of predictable pig performance. Finally, as a cautionary note, the interest in energy as an important variable affecting amino acid utilization must be considered in the context of other dietary nutrients that can confound or complicate our understanding of the energy–amino acid relationship.

Key Words: Amino acids, Energy, Electrolyte balance

6 Effect of dietary lysine intake on nitrogen balance of gilts during different stages of gestation. P. Srichana*¹, A. Gaines¹, G. Allee¹, and J. Usry², ¹*University of Missouri, Columbia,* ²*Ajinomoto Heartland LLC, Chicago, IL.*

Four experiments were conducted to study the effects of dietary lysine levels on N balance in gestating gilts. Nitrogen balance trials were conducted in early gestation (d 40 to 50; Exp. 1); mid-gestation (d 70 to 80; Exp. 2 and 3); and late gestation (d 90 to 100; Exp. 4). In Exp. 1 a total of 24 gilts (Monsanto Chioce Genetics Genepacker) were assigned to one of four levels of dietary lysine intake (9, 12, 15, and 18 g total lysine/d, respectively). In Exp. 2 and 3, a total of 48 gilts (PIC Camborough 22 and Monsanto Choice Genetics Genepacker, respectively) were assigned to one of four levels of dietary lysine intake (9, 12, 15, and 18 g total lysine/d, respectively). In Exp. 4, a total of 24 gilts (PIC Camborough 22) were assigned to one of four levels of dietary lysine intake (12, 15, 18, and 21 g total lysine/d, respectively). In all experiments, four identical corn-soybean meal-based diets were fed. The diets were formulated to be isocaloric (3.30 Mcal ME/kg) and contained 0.44, 0.59, 0.74, and 0.88% total lysine, respectively). All diets met or exceeded the recommendation of NRC (1998) for all other essential amino acids, vitamins, and minerals. The level of feed intake in all experiments was held constant at 2,041 g/d in the early (Exp. 1) and mid-gestation periods (Exp. 2 and 3) and increased to 2,722 g/d in the late gestation period (Exp. 4). During the early (Exp. 1) and mid-gestation periods (Exp. 2 and 3), N retention plateaued at 15 g of total lysine intake/d. In the late gestation period (Exp. 4), N retention plateaued at 18 g of total lysine intake/d. Based on these data, today's modern gilt requires at least 15 g of lysine intake/d during early and mid-gestation and 18 g/d of lysine during late gestation.

Key Words: Sows, Gestation, Lysine

Graduate Student Oral Competition - M.S.

7 Effects of melengestrol acetate on L-selectin and B2-integrin expression of polymorphonuclear leukocytes from heifers challenged with lipopolysaccharide. M. Corrigan*, J. Drouillard, C. Wyatt, E. Loe, B. Deppenbusch, A. Webb, M. Quinn, and H. Wang, *Kansas State University, Manhattan*.

Sixteen crossbred heifers (227 ± 4 kg) were used in completely randomized design to determine the effects of melengestrol acetate (MGA) on polymorphonuclear leukocyte (PMN) L-selectin and B2-integrin expression and leukocyte numbers following *Escherichia coli* endotoxin (LPS) injection. On d 0 heifers were stratified by weight and randomly assigned, within strata, to diets of 53.4% concentrate, 46.6% alfalfa hay, and either 0 or 0.5 mg MGA per heifer daily. On d 24, 1 Mg/kg BW *E. coli* LPS was injected intravenously into all heifers via jugular venipuncture. Blood samples were taken on d 0, 21, and 24 (4 h after LPS injection) and subjected to differential leukocyte counts as well as flow cytometric analysis of CD11b, CD18, and CD62L expression on circulating PMN. Rectal temperatures were also recorded on d 24 (0 and 4 h after LPS injection). Following LPS injection, heifers in both treatment groups experienced decreases in circulating concentrations of all leukocyte populations ($P < 0.01$) except eosinophils which tended to increase ($P = 0.06$). Heifers fed MGA had higher ($P = 0.04$) overall circulating concentrations of neutrophils, but concentrations of other leukocytes were not different between treatments ($P > 0.13$). An effect of sampling time ($P < 0.01$) on the change in mean fluorescence intensity above the isotype control sample (Δ MFI) was observed for CD11b and CD18, with the highest values for both recorded on d 24, 4 h after LPS injection. No effect of treatment on Δ MFI was observed ($P > 0.21$). Heifers fed MGA had lower ($P < 0.02$) rectal temperatures compared to controls, and this appeared to be the result of a more rapid return to normal levels following LPS challenge. Administration of MGA increased circulating concentrations of neutrophils and attenuated the febrile response to LPS, but did not appear to affect cell adhesion molecule expression on circulating PMN.

Key Words: Heifers, Melengestrol acetate, Lipopolysaccharide

8 An epidemiological review of a valine-associated scrapie outbreak: Genetic risk and lateral transmission. J. M. Evoniuk*¹, C. L. Stoltenow¹, K. I. O'Rourke², B. L. Moore¹, and D. A. Redmer¹, ¹North Dakota State University, Fargo, ²USDA, ADRU, Pullman, WA.

Objectives of this retrospective cohort study were to characterize a valine-associated scrapie outbreak, assess the relative risk of scrapie infection in relation to allele frequency at codon 136, and the role of lateral transmission in the outbreak. Codons 136 [encoding valine (V) or alanine (A)] and 171 [encoding glutamine (Q) or arginine (R)] of the prion protein gene affect scrapie resistance or susceptibility. Genotypes at codon 171 ($n = 164$) or codons 136 and 171 ($n = 842$) were assessed in blood samples via a commercial laboratory. One hundred seventy two (20.4%) of the 842 genotyped sheep had at least one valine allele at codon 136 (V_{136}). Because of the high incidence of the $V_{136}Q_{171}$ allelic variant in the flock, genotyping of semen samples was conducted and incidence of at least one V_{136} allele was 14.3% (3 of 21). Scrapie

status was determined via immunohistochemical detection in 160 sheep slaughtered as part of the flock depopulation. Data were analyzed using Epi Info and SAS to calculate relative risk (RR). Forty-four slaughtered sheep were scrapie positive, and the presence of at least one V_{136} was highly correlated with scrapie-positive status. The risk of being scrapie positive was associated ($P = 0.05$) with: sheep with at least one V_{136} allele vs AA_{136} [RR 52, 95% confidence interval (CI) 7:372]; VV_{136} vs AV_{136} (RR 1.7, CI 1.3:2.3); $AVQQ$ and $VVQQ$ vs $AAQQ$ (RR 37, CI 5:261); and $AVQR$ genotype vs $AAQQ$ genotype (RR 15, CI 1.1:195). Lateral transmission was the probable source of infection for four scrapie-positive sheep born to scrapie-negative dams. Because death occurred in all valine scrapie cases before 42 mo from the time of infection, lateral transmission was the source of infection and for an additional 11 sheep in which scrapie was diagnosed at >50 mo of age. In conclusion, results suggest that the outbreak was associated with the high frequency of V_{136} , introduction of a valine-dependent scrapie strain, and the occurrence of lateral transmission.

Key Words: Ovine, Genotype, Scrapie transmission

9 The effect of inorganic and organic trace mineral supplementation on fecal excretion and apparent digestibility of grow-finish swine. J. Burkett*¹, K. Stalder¹, W. Powers¹, J. Pierce², C. Schwab¹, T. Baas¹, and B. Shafer², ¹Iowa State University, Ames, ²Alltech, Inc., Nicholasville, KY.

Two experiments were conducted to compare differences in inorganic and organic trace mineral supplementation in phase-fed, grow-finish swine. Crossbred pigs (Exp1, $n=528$; Exp 2, $n=560$) were blocked by weight, penned by sex, and randomly assigned to treatment pens at approximately 18 kg BW and housed in two totally-slatted confinement barns with ad libitum access to feed and water. Four dietary treatments were allocated in a completely randomized design with 12 replicates per TRT and 9-12 pigs per pen throughout the grow-finish period. The control diet (TRT 1) contained commercially recommended levels of Cu, Fe, and Zn from inorganic sources at a concentration of 85, 169, and 163 mg/kg, respectively. TRT 2 contained commercially recommended levels of Cu, Fe, and Zn from organic sources at a concentration of 19, 131, and 91 mg/kg, respectively. Organic microminerals were reduced to 25 and 50% of levels in TRT2 for TRT3 and TRT4, respectively. In Exp2, TRT 5 contained 25% of the Cu, Fe, and Zn concentrations found in TRT 1. TRT 6 was identical to TRT 4. TRT 7 contained micromineral concentrations at 75% reduction of those found in TRT 2. TRT 8 contained no supplemented microminerals. Feed and fecal samples were collected during each of the four phases. Pigs fed TRT 1 and TRT 5 excreted greater ($P < 0.05$) concentrations of Cu during all four phases. Apparent digestibility of Cu and Zn was greater ($P < 0.05$) for pigs fed diets containing organic sources when compared to pigs fed diets containing the inorganic forms. In Exp 1, fecal concentrations of Fe and Zn were greater ($P < 0.05$) for pigs fed TRT 1 when compared to pigs fed the other dietary treatments.

Key Words: Pig fecal excretion, Trace minerals, Fecal excretion

10 A SNP in the bovine leptin gene: effect on gain and carcass characteristics. D. Larson*, M. Bauer, E. DeVuyst, P. Berg, and J. Bullinger, *North Dakota State University, Fargo.*

A 2-yr study was conducted to determine the effects of a SNP (cytosine to thymine, exon 2) in the bovine leptin gene on growth and carcass characteristics. Calves were identified by genotype (CC = 169, CT = 417, TT = 212). Body weight, 12th rib fat, and LM area were measured serially. Calves were fed a common diet and slaughtered in 4 groups each yr (160 to 208 days on feed). Data were analyzed with PROC MIXED of SAS and mean separation by LSD ($P = 0.05$). Quality and yield grades were analyzed with PROC FREQ of SAS. Twelfth rib fat and LM area change were fitted to an allometric growth model using weighted least squares regression. Initial BW (274 ± 4 kg), final BW (586 ± 4 kg), and ADG (1.63 ± 0.02) were not different ($P = 0.56$) by genotypes. The TT calves had greater ($P = 0.006$) initial 12th rib fat (0.26 ± 0.01 cm) when compared to CT (0.22 ± 0.008 cm) and CC calves (0.22 ± 0.01 cm). Carcass 12th rib fat was greater ($P < 0.001$) in TT (1.36 ± 0.03 cm) compared to CT (1.23 ± 0.02 cm) and CC calves (1.14 ± 0.04 cm). No LM area differences were detected between genotypes at d 0; however, CC calves (83.1 ± 0.80 cm²) had greater ($P < 0.001$) final LM area compared to CT (81.4 ± 0.52 cm²) and TT calves (78.6 ± 0.69 cm²). The CC calves had a slower ($P < 0.001$) rate of 12th rib fat accretion and an increased ($P = 0.001$) rate of LM area accretion compared to TT calves. The TT calves had greater ($P < 0.001$) yield grade (3.35 ± 0.05) compared to CC (2.88 ± 0.06) and CT calves (3.06 ± 0.04). Marbling score ($400 = \text{small}^0$) was greater ($P = 0.01$) in TT calves (457 ± 6) compared to CC (433 ± 7) and CT (439 ± 6) calves. The percentage of carcasses grading average choice or above tended to be different (Chi^2 ; $P = 0.09$) among genotypes (22.0%, 24.8%, and 31.3% for CC, CT, and TT, respectively). The percentage of carcasses with a yield grade = 4 was different (Chi^2 ; $P = 0.05$) among genotypes (4.8%, 10.2%, and 15.2% for CC, CT, and TT, respectively). The CC calves appear leaner, with a slower rate of 12th rib fat accretion and lower marbling scores compared to TT calves.

Key Words: Bovine, Leptin, Fatness

11 Use of infrared thermography to non-invasively determine surface temperatures of limbs of non-lame dairy cows. B. A. Munsell*, A. Ragavendran, D. K. Beede, and A. J. Zanella, *Michigan State University, East Lansing.*

Infrared thermography (IRT) creates a pictorial representation of the surface temperature of an object. It has potential as a method to detect inflammation associated with lameness. In this study, IRT was used to assess surface temperature of the coronary band of the hind limbs of non-lame dairy cows. Ten visibly sound 2-yr-old Holsteins less than 150 d in lactation were clinically examined for soundness. IRT images were obtained six times per day (before and after each of two milkings and again 3 h after milking) for two consecutive days to determine differences in surface temperature at different image angles, different measurement times, among cows, and between limbs of the same cow. Three different image angles were analyzed for both hind limbs: dorsal, lateral and plantar aspects of the coronary band. Images were analyzed using ThermoCAM Reporter 7.0 (FLIR Systems, Inc., Boston, MA). Average and maximum temperatures were determined from an area ap-

proximately 2 cm above and below the coronary band. Maximum temperatures were correlated with average temperatures ($r = 0.826$, $P < 0.01$) and were used for all statistical analyses. Statistical analysis was conducted by a mixed model procedure with cow and cow x side as random effects and time, angle and side as fixed effects. Image angle was a significant factor ($P < 0.05$) with average maximum temperatures of 33.54, 31.86, and 31.75°C for dorsal, lateral and plantar views, respectively. Time of measurement by IRT affected temperatures ($P < 0.05$) with average maximum temperatures ranging from 30.53 to 33.00°C for the six measurement times. After accounting for variation among cows and repeated measures among individuals, there was no difference ($P > 0.05$) between temperatures on left versus right limb within cow. These results suggest that IRT data should be collected using a controlled protocol using a consistent image angle and time of day. Also, differences in temperature measured by IRT between left and right limbs may be useful to detect inflammation associated with lameness in one limb.

Key Words: Infrared thermography, Surface temperature, Lameness

12 Effect of Amaferm supplementation to concentrate or forage based diets on growth performance and carcass characteristics of finishing lambs. J. L. Bard*¹, F. L. Fluharty¹, S. C. Loerch¹, P. S. Kuber¹, G. D. Lowe², D. D. Clevenger², and H. N. Zerby¹, ¹*The Ohio State University, Columbus,* ²*Ohio Agricultural Research and Development Center, Wooster, OH.*

Amaferm® (AMF) is a fermentation extract produced from a select strain of *Aspergillus oryzae* fungi. Ninety-six Dorset x Hampshire lambs (initial weight range 22.7 to 34.0 kg) were used in a complete block experiment with a 2 x 2 factorial arrangement of treatments to determine the effects of AMF supplementation in diets containing either a high proportion of starch (high concentrate; **CON**) or high proportion of cellulose (high forage; **FOR**) on growth performance and carcass characteristics. Lambs were allotted to 24 pens (four lambs per pen) that were blocked by sex and weight. Twelve pens of lambs received the FOR diet and 12 pens were fed the CON diet. Within each diet treatment group, six pens received AMF. Lambs were fed until the average live weight of each pen reached the target weight (55.4 kg for wethers and 50 kg for ewes), at which time the entire pen of lambs was harvested. Live weight was included in the model as a covariate for the analysis of ribeye area, backfat thickness, and body wall thickness. Lambs that received the CON diet consumed less ($P < 0.05$) average DMI (1.42 vs. 1.93 kg) and produced carcasses that had greater ($P < 0.05$) backfat (0.79 vs. 0.65 cm), body wall (2.36 vs. 1.95 cm), and ribeye area (15.13 vs. 13.31 cm²). Supplementation of AMF had no effect ($P > 0.05$) on carcass characteristics. For lambs that received the CON diet, AMF supplementation resulted in improved ($P < 0.05$) feed efficiency (0.257 vs. 0.245) and greater ($P < 0.05$) ADG (0.37 vs. 0.35 kg/d), however, it did not ($P > 0.05$) impact days on feed to reach target end point (73 vs. 70 d). For lambs that received the FOR diet, AMF supplementation resulted in decreased ($P < 0.05$) feed efficiency (0.122 vs. 0.135) and ADG (0.23 vs. 0.26 kg/d), and resulted in a greater ($P < 0.05$) number of days on feed to reach the targeted market endpoint (106 vs. 97 d). Results indicate that at the levels fed, Amaferm® may improve growth performance for lambs finished on high concentrate diets, but not high forage diets.

Key Words: Growth, Carcass, Lamb

13 Effect of corn hybrid and processing method on site and extent of nutrient digestibility using the mobile bag technique.

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Two ruminally and duodenally fistulated steers were used to determine site and extent of nutrient digestion of 3 hybrids: 1) H-8562; 2) 33P67; and 3) H-9230Bt processed as dry-rolled (DRC) or high-moisture corn (HMC) using the mobile bag technique. Dacron bags were the experimental unit for DM disappearance (replications n = 25/treatment), and composited bags were the experimental unit for protein and starch disappearance (replications n = 4/treatment). Two ruminal incubation times of 30 and 20 h were used to represent mean retention time (MRT) and 66% MRT (66MRT), respectively. A hybrid*processing*time interaction (P < 0.05) existed for only postruminal DMD. Ruminal DMD was greater (P = 0.01) for hybrid 1 and 3 compared to hybrid 2. Three interactions (P < 0.05) existed for total-tract DMD: hybrid*processing, processing*time, and hybrid*time. Total-tract DMD was greater for hybrid 1 compared to 2 and 3 when processed as DRC. When processed as HMC, total-tract DMD was similar among hybrids. The % increase in total-tract DMD for DRC samples was greater than HMC when incubated longer. Total-tract DMD was greater for hybrids 1 and 3 at the 66MRT than hybrid 2. At the MRT, total-tract DMD for hybrid 1 was greater than either hybrid 2 or 3. Ruminal starch degradability (SD) was similar (P = 0.14) among hybrids but greater (P < 0.01) for HMC than DRC. Postruminal and total-tract SD were greater (P < 0.01) for hybrid 1 and 3 than hybrid 2, and greater (P < 0.01) for HMC than DRC. Degradable intake protein (DIP; % CP) was similar (P = 0.12) among hybrids, but 32% greater (P < 0.01) for HMC than DRC (71.8 and 54.2%, respectively). Undegradable intake protein (UIP) disappearance was greatest (P = 0.02) for hybrid 1, intermediate for hybrid 3, and least for hybrid 2. Digestible UIP was 5.4% greater (P = 0.03) for HMC than DRC (77.7, and 73.7%, respectively). Differences exist among hybrids for site and extent of nutrient digestibility. Extent of nutrient degradability for HMC was greater than DRC, except postruminal DMD. Digestible UIP and DIP are greater for HMC compared to DRC.

Key Words: Corn hybrid, Digestibility, Kernel traits

14 Growth and performance of Holstein dairy calves fed distillers grains.

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To evaluate the effect of calf starters containing dried distillers grains (DDG) on growth and performance, 39 Holstein bull calves (5.3 days of age; SD 2.4) were blocked by birth weight and randomly assigned to one of three dietary treatments. Diets were formulated for 22% CP. The control diet (C) contained cracked dry corn grain, molasses, rolled oats and 44% CP soybean meal. The two test diets had 28% DDG (T1) and 56% DDG (T2) (DM-basis) respectively, with DDG partially substituting for corn, oats, and soybean meal. Calves were housed individually and fed experimental diets once daily for ad libitum consumption

for 12 wk. All the calves received commercial milk replacer (CP 22%) until weaning at 7 wk of age. Feed intake was measured daily. Body weight, height at hip and withers, and heart girth were measured at birth and at 3, 6, 9 and 12 wk of age. Results were analyzed with repeated measures analysis using mixed procedures in SAS statistical software considering treatment and treatment × week interaction as fixed effects. The average DMI for the calf starter diets were 1.00, 1.05 and 1.15 kg/d (SEM ± 0.07) for C, T1 and T2 respectively with no significant difference between the treatments, but the treatment × week interaction was significant (P < 0.02). DMI of calves fed T2 differed from C (P < 0.03) during week 10 and 11. Average body weights (75.8, 75.1 and 75.3 kg; SEM ± 1.76) and average daily gains (0.82, 0.81 and 0.81 Kg; SEM ± 0.03) were similar (P > 0.05). Feed efficiencies, defined as ratio of average daily DMI to average daily gain differed among treatments (2.36, 2.62 and 2.86; SEM ± 0.11) with T2 significantly differing from C (P < 0.01). Heart girth (95.8, 95.8 and 96.4 cm; SEM ± 0.66) and hip height (89.5, 89.8 and 90.7 cm; SEM ± 0.45) were similar (P > 0.05) for all the treatments. Withers height (85.4, 85.0 and 86.5 cm; SEM ± 0.39) differed between T1 and T2 (P < 0.02). Calves fed C and T2 tended to differ for withers height (P < 0.07). This study indicated that the inclusion of DDG in calf starters at moderate levels (28%) did not affect the growth and performance of dairy calves, but at higher levels (56%) decreased feed efficiency.

Key Words: Distillers grain, Calves, Growth

15 Effect of feeding a byproduct combination at two levels or byproduct alone in feedlot diets.

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A finishing study was conducted to evaluate feeding a byproduct combination relative to feeding byproducts alone. Wet corn gluten feed (WCGF; Sweet Bran, Cargill, Blair, NE) and wet distillers grains with solubles (WDGS; Abengoa, York, NE) were used in a combination (1:1 DM basis) at two inclusion levels (30 and 60% DM basis) or fed alone (30% DM basis) in dry rolled:high moisture corn (1:1 DM basis) feedlot diets. A control corn-based diet was also fed. All diets contained 7.5% alfalfa hay and 5% dry supplement. Backgrounded calf-fed steers (n=250; 343 ± 13.5kg) were used in a RCBD (three weight blocks, ten steers/pen, five pens/treatment) to evaluate ADG, DMI, and G:F. Steers were fed for 124 days and slaughtered on d 125 at a commercial abattoir to collect carcass data. Final BW were heaviest for 30% WDGS (608kg) and lightest for control cattle (574kg), while cattle fed the 60% byproduct blend were slightly heavier than control cattle, and cattle fed 30% blend had final BW between those fed 30% WCGF and 30% WDGS. ADG increased (P<0.01) with addition of any level of byproducts in the diets. DMI increased (P<0.01) with dietary byproduct inclusion relative to control (10.8kg), with highest intake for 30% WCGF fed cattle (11.9kg). Feed efficiency was highest for 30%WDGS fed cattle; while, feeding a byproduct blend at 60% of diet DM was still superior to control fed cattle. Other than carcass weight and calculated USDA yield grade, no other carcass data differences were observed among treatments. Feeding WCGF and WDGS in a combined blend or alone to feedlot cattle improved gain and efficiency over control fed cattle.

Table 1.

Treatment	^a :CON	30WCGF	30Blend	30WDGS	60Blend	SE
ADG, kg	1.85 ^b	2.03 ^d	2.07 ^{de}	2.12 ^e	1.94 ^c	0.05
DMI, kg/d	10.8 ^b	11.9 ^d	11.5 ^{cd}	11.4 ^c	10.8 ^b	0.3
G:F kg/kg	0.172 ^d	0.171 ^d	0.179 ^c	0.187 ^b	0.179 ^c	0.070

^a Blend = 1:1 WCGF:WDGS (DM basis) at 30 and 60% dietary inclusion. ^{b, c, d, e} Means with different superscripts differ $P < 0.05$.

Key Words: Gluten feed, Distillers grains, Corn

16 Evaluating in vitro neutral detergent fiber digestibility of high-fiber byproduct feeds and forages. J. Wakker^{*1}, H. G. Jung^{1,2}, and J. G. Linn¹, ¹University of Minnesota, St. Paul, ²USDA-Agricultural Research Service, St. Paul, MN.

In vitro neutral detergent fiber digestibility (IVNDFD) is being used to evaluate feeds for quality and purchase. The objective of this study was to evaluate the repeatability of IVNDFD analysis over time using 12 forages and 10 high-fiber byproduct feeds. During a 6-wk experimental period, ruminal contents were collected once a week on a bi-weekly basis from a single lactating Holstein cow. Ankom filter bags containing

0.5 g of each feedstuff were incubated, in duplicate, for 48 h at 39°C using the Daisy Oven system. Data were analyzed using PROC GLM of SAS. Week of rumen fluid collection significantly ($P < 0.05$) affected IVNDFD across feeds with collection 2 having lower IVNDFD values than collections 1 and 3. Ranking by IVNDFD of forages, but not byproduct feeds, was affected ($P < 0.05$) by collection. Average IVNDFD for whole cottonseed and wheat middlings were 32 and 54%, respectively, while the other 8 byproduct feeds ranged from 84 to 91% IVNDFD. For a conventional corn silage sample, collections 1 and 3 were higher ($P < 0.05$) in IVNDFD than collection 2 (67 & 66 vs. 45%). A brown midrib (BMR) corn silage's IVNDFD was higher ($P < 0.05$) for collection 3 compared to collections 1 and 2 (73 vs. 60 & 59%). Comparing the conventional and BMR corn silages, IVNDFD was different for collection 2 (45 vs. 59%), but not different for collections 1 (67 & 60%) and 3 (66 & 73%). Three alfalfa samples (1 haylage and 2 hays) did not differ for their IVNDFD values across collections, but ranking by IVNDFD within rumen collections revealed differences. Haylage was higher ($P < 0.05$) in IVNDFD than hays 1 and 2 for collection 1 (62 vs. 53 & 52%), similar to hays 1 and 2 for collection 2 (54 vs. 51 & 50%) and higher ($P < 0.05$) than hay 2 for collection 3 (58 vs. 50 vs. 47%). Repetitive rumen fluid collections under standardized conditions resulted in different IVNDFD values for individual feeds. Ranking of forages, but not byproduct feeds, varied among rumen fluid collections.

Key Words: NDF digestibility, Byproduct, Forage

Graduate Student Oral Competition - Ph.D.

17 Effects of ruminal protein degradability and frequency of supplementation on net flux of N in visceral tissues of lambs fed a low-quality forage. R. L. Atkinson^{*1}, C. D. Toone¹, D. L. Harmon², and P. A. Ludden¹, ¹University of Wyoming, Laramie, ²University of Kentucky, Lexington.

Fifteen multi-catheterized wether lambs (34 ± 4 kg) were used in a completely randomized designed experiment to measure net flux of N metabolites across the portal-drained viscera (PDV), liver, and total splanchnic (TS) tissues in response to alternate day supplementation with ruminally degradable protein (RDP) vs. ruminally undegradable protein (RUP). Wethers were fed a basal diet of mature crested wheat-grass hay (4.2% CP) for ad libitum consumption plus one of four supplements: 1) a high RDP supplement based on isolated soy protein, formulated to meet estimated RDP requirements assuming a microbial efficiency of 11% of TDN, provided daily (RDP-D), 2) the high RDP supplement provided on alternate days (RDP-A), 3) a high RUP supplement based on corn gluten meal, fed on an iso-N basis to RDP-D, provided on alternate days (RUP-A), or 4) a 50:50 mixture of the RDP and RUP supplements, provided on alternate days (MIX-A). Supplementation rates for the alternate-day treatments were at twice that of daily supplementation (N basis). Net release of ammonia N from the PDV was decreased ($P = 0.05$) in RUP-A lambs on day of supplementation (DOS), and was decreased ($P = 0.05$) in all alternate-day treatments on day of non-supplementation (NS). Consequently, hepatic uptake of ammonia N was lowest ($P = 0.06$) in RUP-A lambs on DOS, with a decrease ($P = 0.06$) in uptake for all alternate day treatments on NS. In spite of the changes in ammonia N uptake by the liver, hepatic output ($P = 0.62$) and PDV uptake ($P = 0.50$) of urea N were not affected by treatment, day, or treatment \times day. The lack of difference in

hepatic urea N output in spite of differences in ammonia N uptake by the liver, particularly on the day following supplementation, suggests that N sources other than PDV-derived ammonia (i.e. amino acids) may be utilized as a source of N for ureagenesis between supplementation events, thereby enhancing the potential for N recycling.

Key Words: Portal-drained viscera, Ruminally undegradable protein, N Recycling

18 Dietary supplementation of oregano essential oils (OEO) on the performance of nursery pigs. C. Ariza-Nieto^{*}, S. K. Baidoo, and R. Walker, University of Minnesota, St. Paul.

An experiment evaluated the supplementation of OEO in gestation and lactation sow and nursery diets on the growth performance, energy and nitrogen digestibility and intestinal health of pigs. The experiment involved 384 19-d old pigs weaned from sows fed control (corn-SBM) or oregano (C+250ppm of Regano500®) diets. The pigs were randomly assigned to one of the 4 nursery treatments: control (C), antibiotic (AB), oregano; 1000ppm (O), O plus AB (OAB). Piglets were individually weighed at 19, 26, 33, and 54 days of age. 48 piglets at 33 days of age were moved to individual metabolism crates for digestibility study. Six pigs from each dietary treatment were randomly selected at the end of the digestibility study for morphology measurements and microbial study. Intestinal tissues were collected at 25% (Proximal), 50% (Mid), and 75% (Distal) of small intestine to measure crypt depth and villus

height. About 5 g of cecum content were collected to isolate microbial colonies for antibiotic sensitivity test. Data were analyzed as split plot design with a 2x4 factorial arrangement (whole plot=sow diet, split plot=pig diet) using the MIXED procedure of SAS. Weaning pigs from OEO sows grow faster than control pigs (386 v 354 g/d, $P < 0.01$). Pigs with OEO showed higher levels of ME ($P < 0.05$) when compared to C, but similar to pigs with antibiotic (OAB: 376, O: 369, AB: 361, C: 352 Kcal (kg wt^{0.75})⁻¹d⁻¹). Pigs from OEO sows consumed more N (74.7±2.4 v 64.8±2.4 g), excreted more N in feces (4.7±0.2 v 3.8±0.2 g) and retained more N than pigs from C sows (55.5±2.1 v 47.8±2.1 g) during the digestibility period ($P < 0.05$). Pigs fed OEO and/or antibiotics (O, OAB, AB) had greater villi: crypt ratio in proximal and mid intestines compared to C pigs. C group showed higher number of *E. coli* (7.2e5 CFU ml⁻¹), and showed no resistance to Aminoglycoside. Pigs fed OEO showed the lowest resistance to Sulphanomides (62.5%), but the highest resistant was by OAB (97.5%). The growth pattern of early weaned pigs from sows fed OEO is greater than that achieved in current conventional systems.

Key Words: Oregano, Growth, Morphology

19 Effect of diet on apparent intestinal retention of methionine and 2-hydroxy-4-methylthiobutanoic acid in pigs. G. Malik^{*1}, M. D. Drew¹, D. Hoehler², M. Rademacher², and A. G. Van Kessel¹, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Degussa Corporation, Kennesaw GA.

Previously, we have shown increased intestinal retention of 2-hydroxy-4-methylthiobutanoic acid (MHA-FA) relative to DL-methionine (MET) in conventional but not germ-free chicken supporting a microbial contribution to differences in bioefficacy of methionine sources. Here, we investigated the effect of feeding corn or wheat/barley-based diets on apparent retention of MET and MHA-FA in the pig small intestine (SI), with both sources supplemented on an equimolar basis. In each of two replicate studies, 16 pigs were weaned at 14 d of age and assigned to one of 4 experimental diets in 2 x 2 factorial design. Following an overnight fast at 24 d of age, pigs were fed their respective diets (20 g/kg BW) containing either ³H-L-MET or ³H-L-MHA-FA and chromic oxide as a meal. After 3 hrs pigs were killed and digesta was collected from stomach and locations corresponding to 5, 25, 50, 75 and 95% of SI length. Viscosity and pH were estimated at 75% location whereas total aerobes, total anaerobes, lactobacilli, enterococci and enterobacteriaceae were enumerated at 25 and 75% of SI by standard plate counts. Residual MET and MHA-FA in digesta were calculated as the ratio of ³H:chromic oxide in digesta samples to the ratio of ³H:chromic oxide in feed. Feeding a wheat/barley-based diet increased ($P < 0.05$) viscosity and total aerobes at 25% of SI, whereas supplementation with MHA-FA increased ($P < 0.05$) total aerobes and lactobacilli counts at 25% of SI. Diet composition did not affect retention of MET or MHA-FA. Both MET and MHA-FA were retained in stomach (93 and 92%, respectively) but disappeared rapidly from proximal SI such that, respectively, apparent retention was 17 and 32% at 25% of SI length ($P < 0.01$) and 8 and 13% at 95% of SI length ($P < 0.01$). As previously observed in chicken, MHA-FA retention in pig small intestine is greater than that of MET, which may explain in part the differences in bioefficacy of these methionine sources.

Key Words: DL-methionine, Methionine hydroxy analog, Microbiota

20 Chronic exposure of ruminal fluid cultures to treatments that inhibit methanogenesis. E. Behlke^{*1}, J. Takacs¹, S. Ragsdale¹, C. McNeff², P. Newsome³, and J. Miner¹, ¹University of Nebraska, Lincoln, ²SarTec Corporation, Anoka, MN, ³PharmAgra Labs, Inc., Brevard, NC.

Methane production by acute cultures of ruminal fluid is inhibited by a nitrofuranyl *p*-aminobenzoic acid derivative (NFP), 2-bromoethanesulfonate (BES), and *Yucca schidigera* (Yucca). Our objective was to determine the extent to which cultures develop resistance to these inhibitors following chronic exposure. Eight cultures were inoculated with ruminal fluid and chronically exposed in duplicate to: 1) control; 2) 100 MM NFP; 3) 10 MM BES; and 2.50 ML/mL Yucca. Every two days 50% of each culture was replaced with fresh medium. On d 2, 10, 22, 32, 40, 60, and 90, chronic cultures were used to inoculate acute cultures. Acute cultures were treated in duplicate with either 0 or 10X the same inhibitor as used for creating the chronic culture inoculum ($n = 24/d$). Control-inoculated acute cultures were also treated in duplicate as controls and with these 10X doses of NFP, BES, and Yucca ($n = 16/d$). On all days NFP, BES, and Yucca decreased ($P < 0.05$) CH₄ production by control-inoculated cultures. Chronic treatment with NFP created an inoculum that by d 40 generated 77% less ($P < 0.05$) CH₄ than did the control. When this inoculum was treated with a 10X concentration of NFP, CH₄ production was reduced ($P < 0.05$) by 100%. We conclude that chronic NFP treatment diminishes an inoculum's ability to generate CH₄ and the inoculum maintains its sensitivity to the 10X dose of NFP. Chronic treatment with BES created an inoculum that by d 10 produced a similar amount of CH₄ as did the control, but when treated with a 10X dose of BES methanogenesis was decreased ($P < 0.05$) by 67%. We conclude that chronic BES treatment creates an inoculum that is resistant to a low dose of BES but remains sensitive to a 10X dose. Chronic treatment with Yucca created an inoculum that did not produce less CH₄ than did the control and by d 20 was not sensitive to the effects of the 10X dose of Yucca. We conclude that chronic Yucca treatment results in an inoculum that is resistant to both low and 10X concentrations of Yucca.

Key Words: Methane, BES, Yucca

21 Dietary L-arginine supplementation improves pregnancy outcome in gilts. R. D. Mateo^{*1}, G. Wu^{1,2}, J. A. Carroll³, I. Shinzato⁴, and S. W. Kim^{1,2}, ¹Texas Tech University, Lubbock, ²Texas A&M University, College Station, ³USDA-ARS-LIRU, Lubbock, TX, ⁴Ajinomoto, Tokyo, Japan.

This study was conducted to determine the effect of dietary L-arginine supplementation on the production performance of pregnant gilts. A total of 53 pregnant gilts with an initial body weight of 166.25±1.81 kg and backfat thickness of 13.26±0.21 mm were housed individually in gestation crates. At d 30 of gestation, gilts were assigned randomly to corn- and soybean-based diets supplemented with 1.0 % L-arginine (treatment group) or 1.7 % L-alanine (isonitrogenous control). Both diets contained 3.1 Mcal ME/kg and 12.2% CP. Gilts were fed 1 kg twice a day at 0700 and at 1700 h during the gestation period. Maternal body weight and backfat thickness were measured on d 30, 50, 70, 90 and 110 d of gestation. At d 110 of gestation, gilts were transferred to individual farrowing crates. The numbers of total pigs born and born

alive as well as birth weights of piglets were recorded immediately after farrowing. At d 110 of gestation, maternal body weight ($P=0.603$) and backfat thickness ($P=0.349$) did not differ between the control and treatment groups. The total number of pigs born did not differ ($P=0.102$) between the two groups of gilts. However, compared with the control group, arginine supplementation increased the number of pigs born alive by 23% (11.23 vs. 9.12, $P=0.029$) and litter birth weight by 28% (15.80 vs. 12.37 kg, $P=0.005$). These results demonstrate, for the first time, that dietary L-arginine supplementation improves pregnancy outcome in gilts. Supported by Texas Tech Univ., Texas A&M Univ., Ajinomoto, and USDA/NRI.

Key Words: Gestation performance, Gilts, Arginine

22 QTL mapping in an F_2 Duroc x Pietrain resource population: II. Carcass and meat quality traits. D. B. Edwards*¹, C. W. Ernst¹, N. E. Raney¹, M. E. Doumit¹, M. D. Hoge^{1,2}, and R. O. Bates¹, ¹Michigan State University, East Lansing, ²Western Illinois University, Macomb.

Pigs from the F_2 generation of a Duroc x Pietrain resource population were evaluated to discover quantitative trait loci (QTL) affecting carcass composition and meat quality traits. Carcass composition phenotypes included primal cut weights, skeletal characteristics, backfat thickness, muscle pH, and carcass temperature. Meat quality data collected on boneless *longissimus* muscle chops included objective and subjective color information, marbling and firmness scores, and drip loss. Additionally, chops were analyzed for moisture, protein, and fat composition as well as cook yield and Warner-Bratzler shear force measurements. Palatability of chops was determined by a trained sensory taste panel. A total of 510 F_2 animals were genotyped for 124 microsatellite markers evenly spaced across the entire genome. Data were analyzed with line cross least squares regression interval mapping methods using sex and litter as fixed effects and carcass weight or harvest age as covariates. Significance thresholds of the F-statistic for additive, dominance, and imprinted QTL were determined on chromosome- and genome-wide levels by permutation tests. A total of 94 QTL for 35 of the 38 traits analyzed were found to be significant at the 5% chromosome-wise level. Of these 94 QTL, 16 were significant at the 1% chromosome-wise, 13 at the 5% genome-wise, and 14 at the 1% genome-wise significance thresholds. Putative QTL were discovered for 45 min pH and pH decline on SSC 3, marbling score and carcass backfat on SSC 6, carcass length and number of ribs on SSC 7, marbling score on SSC 12, and color measurements and tenderness score on SSC 15. These results will facilitate fine mapping efforts to identify genes controlling carcass composition and meat quality traits that can be incorporated into marker-assisted selection programs to accelerate genetic improvement in pig populations.

Key Words: Meat quality, Pigs, Quantitative trait loci

23 Differential gene and protein expression in gilt and sow derived oocytes. M. Paczkowski*, D. Terry, C. Bidwell, and R. Krisher, Purdue University, West Lafayette, IN.

Gilt derived oocytes matured in vitro demonstrate decreased ability to undergo embryonic development compared to sows, suggesting reduced

oocyte competence. Gene transcripts present in oocytes may reflect developmentally important mechanisms. Alternatively, identifying possible regulatory proteins involved in successful oocyte maturation could result in methods to enhance the competence of oocytes from prepubertal pigs and increase developmental potential. We hypothesize that by comparing gene expression and protein complement in oocytes with high and low developmental potential, we can identify differentially expressed genes that may play a role in mechanisms controlling oocyte competence. Sow and gilt cumulus-oocyte-complexes (COC) were collected from 2 to 6mm follicles and matured for approximately 43 h in either defined Purdue Porcine Media (PPMmat), or TCM199 medium (supplemented with 10% porcine follicular fluid, 0.5 mM cysteine, 0.91 mM pyruvate, and 3.05 mM glucose) for microarray and protein analysis, respectively. After maturation, COCs were denuded and assessed for maturation, as indicated by polar body extrusion. Dynabead Direct mRNA isolation reagents were used to isolate poly A+ mRNA ($n=200$ oocytes) for input into the Affymetrix microarray two-cycle amplification and labeling system. Two dimensional gel electrophoresis was performed on oocyte samples ($n=3000$) and gels were stained with silver nitrate. Protein spots ($n=14$) were digested with trypsin and analyzed by mass spec. The results of these preliminary experiments show that pig oocytes express about 8,800 transcripts (36% of the probe sets) that are detectable by the pig Affymetrix GeneChip. Differential expression was observed in 292 proteins; 120 proteins identified in gilts were absent in sows, while only 55 proteins were identified in sows that were absent in gilts. Seven proteins were identified with high confidence. Differentially expressed genes and proteins will be further analyzed and their potential roles in developmental competence of oocytes investigated.

Key Words: Porcine Oocyte, Microarray, Protein Analysis

24 Effects of L-carnitine and gestation length on growth factor messenger RNA (mRNA) expression in maternal tissues. K. R. Brown*¹, R. D. Goodband¹, M. D. Tokach¹, S. S. Dritz¹, J. L. Nelssen¹, J. E. Minton¹, D. M. Grieger¹, J. C. Woodworth², and B. J. Johnson¹, ¹Kansas State University, Manhattan, ²Lonza, Inc, Allendale, NJ.

Fifty-nine gestating gilts (BW=137.7 kg) were used to determine the effects of dietary L-carnitine on the IGF system expression in maternal reproductive tissues. Treatments were designed as a 2×3 factorial arrangement with diet (L-Carnitine or control) and gestation day (40, 55, or 70) as main effects. Gilts were fed a gestation diet once daily (1.75 kg) with a 50-g top dress containing either 0 ($n=30$) or 88 mg (50 ppm) of L-carnitine ($n=29$) from breeding through d 40, 55, or 70 of gestation when maternal reproductive tissues were collected. Real-time quantitative PCR was used to measure growth factor messenger RNA (mRNA) levels in uterine, myometrial, and endometrial tissues. There were no interactions between diet and gestation day. Supplementing gilts with L-carnitine increased endometrial IGFBP-3 ($P=0.05$) and IGFBP-5 ($P=0.01$) mRNA abundance, and numerically increased IGF-I ($P=0.16$; 4.52 vs. 3.34). Endometrial IGF-I, IGF-II, IGFBP-3, and IGFBP-5 mRNA levels were not different among gestation lengths. Carnitine did not influence myometrial or placental IGF-I, IGF-II, IGFBP-3, and IGFBP-5 mRNA abundance. As gestation increased from d 40 to 55, IGF-I, IGFBP-3, and IGFBP-5 mRNA abundance decreased ($P<0.04$) in the myometrium with no differences as gestation increased from d 55

to 70. Placental IGF-I tended to increase ($P=0.08$) as gestation length increased. This data suggests supplementing gilts with L-carnitine affected expression on IGF-I, IGFBP-3 and IGFBP-5 mRNA in the endometrium of the porcine uterus, therefore altering the IGF system in the uterine environment. In addition, changes occurred in growth factor expression in the myometrium of the porcine uterus and placental tissue as gestation length increased. These data may aid in the explanation of the improvements in fetal birth weight and litter size from sows fed L-carnitine observed in previous studies.

Key Words: Carnitine, Gilt, Messenger RNA

25 Pretreatment of swine jejunal epithelial cells (IPEC-J2) with *Bacillus licheniformis* (BL) prevents *Salmonella enterica* serovar Typhimurium (ST)-induced basolateral interleukin 8 (IL-8) secretion. K. A. Skjolaas*, T. E. Burkey, and J. E. Minton, *Kansas State University, Manhattan*.

Although no single class of alternatives has emerged to replace the enhanced growth performance afforded by in-feed antibiotics in weaned pigs, a number of products appear to recapture a portion of the advantage. Direct-fed microbials are among those products, including those containing *Bacillus* spp. However, the mechanism of action by which *Bacillus* functions in the gut has yet to be fully understood. Direct-fed microbials may affect inflammatory signaling in the gut epithelium in response to invasive enteric pathogens. Thus, the objective of the current study was to evaluate IL-8 secretion induced by ST in IPEC-J2 cells pre-exposed to BL. IPEC-J2 cells were grown to confluency and treated apically overnight with 10^6 , 10^7 , or 10^8 BL (BL6ST, BL7ST, BL8ST, respectively) followed by a 1 hr apical ST (10^8) challenge. Cells were then washed and media containing 50 Mg/mL gentamicin was added to kill remaining extracellular bacteria. Three control treatments included cells exposed to 10^8 BL alone, 10^8 ST alone, or cells not exposed to any bacteria (CTL). Supernatants were collected 5 hr after ST challenge and IL-8 secretion was quantified by ELISA. The secretion of IL-8 was significantly increased as compared to CTL in both the basolateral and apical directions by ST ($P < 0.0001$) with significantly greater basolateral polarization ($P < 0.05$). The BL treatment and all BL and ST co-treated cells (except BL8ST) increased IL-8 secretion above CTL, but only apically ($P < 0.05$ for BL, BL6ST and BL7ST), and not in the basolateral direction. The data demonstrate that porcine jejunal epithelial cells increase IL-8 secretion in both the apical and basolateral directions in response to ST, but in the presence of BL, ST stimulated secretion of IL-8 is inhibited in the basolateral direction.

Key Words: Direct-fed Microbials, Gastrointestinal Immunology, Interleukin 8

26 Diurnal and dietary impacts on purine derivative excretion from spot samples of urine in finishing heifers. G. I. Crawford*, K. J. Vander Pol, J. C. MacDonald, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln*.

Individually-fed crossbred heifers ($n=116$; 407 ± 32 kg) were arranged into a randomized complete block design to determine impacts of diet

on growth performance and carcass characteristics and the impact of diet and time of sampling on purine derivative (PD; allantoin + uric acid) excretion in spot samples of urine. Treatments were arranged into a 2 x 3 factorial design, with two urine spot sample collection times (0700 and 1700 h; AM and PM) and three diets: 85% steam-flaked corn (SFC); 85% SFC + 1.5% urea (UREA); or 25% SFC, 30% wet corn gluten feed, and 30% corn bran (BYPROD). No collection time x diet interaction was present for any variable ($P > 0.20$). Dry matter intake was greatest with the BYPROD diet and lowest with the SFC diet ($P < 0.05$), averaging 7.9, 8.8, and 10.4 kg/d for SFC, UREA, and BYPROD diets, respectively. Heifers consuming BYPROD and UREA diets gained 1.7 and 1.6 kg/d, respectively ($P > 0.20$), which were both greater ($P < 0.05$) than heifers consuming the SFC diet (1.1 kg/d). Feed efficiencies were 0.138, 0.180, and 0.162 for SFC, UREA, and BYPROD diets, respectively, with UREA being the greatest and SFC the lowest ($P < 0.05$). Heifers fed the BYPROD diet had a greater ($P < 0.05$) PD:creatinine ratio (PD:C) than heifers fed either the SFC or UREA diet, suggesting the BYPROD diet produced greater microbial CP (MCP) flows than either the SFC or UREA diet. Heifers fed the UREA diet had a greater ($P < 0.05$) PD:C than those fed SFC alone, with PD:C measuring 0.94, 1.18, and 1.25 $\mu\text{M PD}/\mu\text{M creatinine}$ for the SFC, UREA, and BYPROD diets, respectively. Urine spot sampling time had a significant ($P < 0.05$) impact on PD:C, with samples measuring 1.03 and 1.22 $\mu\text{M PD}/\mu\text{M creatinine}$ for AM and PM samples, respectively. Feeding diets varying in energy and protein produced significant impacts on performance as well as MCP production in heifers. It appears that collecting urine spot samples in PM results in greater estimates of MCP when compared with AM sampling.

Key Words: Heifers, Purine derivatives, Spot samples

27 Diets containing low vitamin A and roasted soybeans affect adipose cellularity and muscle fatty acid profile of beef cattle. M. Gorocica-Buenfil*, C. Reynolds, F. Fluharty, and S. Loerch, *The Ohio State University, Wooster*.

A feedlot trial was conducted to determine the effect of low vitamin A diets (LA) and roasted soybean inclusion (SB) on adipose tissue cellularity and muscle fatty acid composition. Angus-based steers ($n=168$; BW=295 kg) were allotted to 24 pens (7 steers each). Four dietary treatments were investigated: LA (1100 IU/kg DM)–No SB (LA–NS); LA–SB; High vitamin A (HA, 2700 IU/kg DM)–NS; and, HA–SB. Diets included high moisture corn (65–80%), 5% corn silage, 10–20% supplement, and 20% roasted soybean in SB treatments. Steers were harvested on d 168, and longissimus muscle (LM), intramuscular (IM) and subcutaneous (SQ) fat samples were collected from two animals per pen. To measure adipose cellularity, the SQ and IM fat samples were stained with hematoxylin–eosin solution, and cell number and diameter were determined by computer image analysis. Rib samples were taken for muscle fatty acid composition (MFA). Fatty acids were extracted and analyzed by gas chromatography. Adipocyte size and number were affected by diet for the IM ($P < 0.05$) but not for the SQ depot ($P > 0.05$). A SB x vitamin A (VA) interaction occurred ($P < 0.05$) for IM fat cellularity. Steers fed the LA–NS, LA–SB, and HA–SB diets had more and smaller adipocytes than those fed the HA–NS diet (156.6, 154.0, 156.4, and 119.0 adipocyte/ mm^2 ; 85.8, 87.7, 86.3, and 97.8 μm , respectively; $P < 0.05$). Vitamin A did not affect MFA ($P > 0.05$). Including SB in-

creased ($P < 0.05$) polyunsaturated fatty acids (7.88 vs. 4.30 g/100 g for SB and NS respectively), and reduced ($P < 0.05$) saturated fatty acids in muscle (45.02 vs. 46.55 g/100 g for SB and NS respectively). The CLA content of LM was not affected ($P > 0.05$) by diet. Including SB improved beef nutrient profile, increasing its PUFA and reducing its saturated fat content. Adipocyte hyperplasia was apparently stimulated by LA diets and SB inclusion in the IM but not in the SQ depot. Increasing the number of adipocytes in the IM depot without affecting the SQ depot may improve carcass USDA quality grade without affecting yield grade.

Key Words: Beef, Adipose, Vitamin A

28 Genetic background alters gene expression in response to dietary phosphorus in porcine muscle. A. Qu*, M. Rothschild, and C. Stahl, *Iowa State University, Ames.*

Phosphorus (P) plays a vital role in growth and development, however little research has focused on the genetic mechanisms controlling P utilization. We examined the influence of genetic background and dietary P

on the expression of a variety of genes involved in the regulation of growth in muscle tissue. Thirty-six gilts (21d of age, 6.63 ± 0.78 kg) from 6 litters (3 pigs/litter) for each of 2 sire lines were allotted into 3 dietary treatment groups: P adequate (+P, 0.41% available P), P repletion (RP, 0.14% available P for wk 1, 0.41% available P for wk 2), or P deficient (-P, 0.14% available P) for 2 wks. Using real-time PCR, we quantified the gene expression of IGF1, IGFBP3, IGFBP5, growth hormone receptor (GHR), parathyroid hormone receptor (PTHr), Calcitonin receptor (CALCR), Vitamin D receptor (VDR), and Oxytocin receptor (OXTR) in the longissimus dorsi muscle. The relative gene expression levels in muscle samples from all gilts were analyzed using a mixed-model, which included the fixed effects of sire line, diet and sire line by diet interaction. A sire by dietary P interaction ($P < 0.1$) was seen for the expression of IGF1, IGFBP3, IGFBP5, GHR, CALCR, VDR, and OXTR. A dietary P effect ($P < 0.1$) was seen on the expression of IGFBP5, IGFBP3 and PTHr. Our results demonstrate that there are significant interactions between nutrition and genetic background that affect gene expression in porcine muscle. Elucidating these interactions may enable for the selection of pigs that will require less P, as well as allow for the recommendation of specific genetic lines for producers with different waste management strategies. These genes may provide targets or lead to strategies to increase the efficiency of growth in domestic animals in a more environmentally friendly manner.

Key Words: Phosphorus, Genetic background, Gene expression

Undergraduate Student Oral Competition

29 A serum free culture for the study of ex-vivo porcine cartilage metabolism. J. Wheeler*¹, J. Rush², J. Spencer², P. Wolf¹, and M. Orth¹, ¹*Michigan State University, East Lansing*, ²*JBS United, Inc., Sheridan, IN.*

Reports suggest that 6-35% of sows are culled due to lameness. Evaluating joint health is difficult and limited by no practical non-invasive procedures. One method feasible in swine would be to evaluate cartilage metabolism in an ex vivo setting. Thus, our objective was to establish a porcine explant culture to study cartilage metabolism. Specifically, we wanted to determine if ex vivo cartilage would respond to cytokine stimulation in a uniquely formulated serum free medium. Two humeral-ular joints from each of six sows were obtained and articular cartilage explants (6 mm discs; 2 discs per well) were cultured over a 3-day period. Medium (1 ml/well) was composed of Gibco D-MEM/F-12, amino acids, lactalbumin (2 ug/ml), Penicillin and Streptomycin (100 U/ml pen & 100 mg/ml strep), manganese sulfate (1.69 ng/ml), dexamethasone (100 pg/ml), insulin (5 ug/ml), transferrin (5 ug/ml), and sodium selenite (5 ng/ml). Half of the samples were supplemented with porcine interleukin-1 (pIL-1) at 5 ug/ml to stimulate catabolism. The production of nitric oxide, prostaglandin E₂, and interleukin-6 (IL-6), all indicators of inflammation, were quantitated in the media. Proteoglycans released into the media were measured as an indicator of cartilage degradation. Data were analyzed using SAS with significant treatment differences set at $p < 0.05$. When pIL-1 was added to the media it induced a significant increase in nitric oxide, prostaglandin E₂, and IL-6 production versus the control (6.3, 2.3, and 4 times as much respectively). Proteoglycan degradation increased in the explants treated with pIL-1 as well. Thus, pIL-1, under the culturing conditions we established, does induce a catabolic effect on cartilage explants. We believe ex vivo explants will be

a good analytical tool to evaluate the quality of cartilage isolated from pigs. Using this model, we would like to study the effects of diet, genetics, and husbandry on joint health in gilts and sows.

Key Words: Cartilage, Inflammation, Ex vivo

30 Differences in aggression between commercial pigs from the years 1980 and 2005. J. Young*, D. Hanson, E. van Heugten, M. See, and J. Cassady, *North Carolina State University, Raleigh.*

The objective of this research was to determine if present day commercial pigs differ in aggressiveness toward other pigs when compared to commercial pigs from 25 years ago. Commercial pigs representing the year 1980 were obtained from dams that have been selected to keep gene indices close to zero (minimization of genetic improvement) and were artificially inseminated using frozen boar semen from Duroc and Hampshire boars from the year 1980. Therefore, old genetic animals represent commercial pigs in 1980. New genetic animals were obtained from a commercial farm and represent commercial pigs in the year 2005. Pigs of a common sex and genetic type were penned together in groups of three. Each pig was tested twice with tests being one week apart. Resident intruder tests were conducted by dividing pens in half and moving a resident pig into the empty half. An intruder pig was then introduced. Attack latency was recorded as time from when an intruder pig entered the pen until an attack occurred. Attack latencies were summed for the two tests. If no attack occurred then latency was 180 seconds. A resi-

dent-intruder score (RIS) was given for the number of attacks (0, 1, or 2) during the two tests. Genetic type and sex were both found to be significant for attack latency ($P < 0.03$ and $P < 0.04$, respectively) and RIS ($P < 0.05$ and $P < 0.01$). On average, pigs of the new genotype attacked 22 seconds faster and 0.20 more times than old genetic pigs and gilts attacked 22 seconds faster and 0.27 more times than barrows. Commercial pigs from 2005 were more aggressive toward a foreign pig than commercial pigs from 1980. One interpretation of these results is that selection for increased lean growth rate has resulted in correlated changes in behavior.

Key Words: Genetics, Behavior, Pigs

31 A comparison of bygholm sieve to standard particle size analysis techniques. C. Benz*, M. Tokach, C. Groesbeck, S. Dritz, R. Goodband, J. Nelssen, and J. DeRouchev, *Kansas State University, Manhattan*.

Two experiments were conducted to evaluate the Bygholm Feed Sieve Particle Size Tester (BFS). The BFS is a $28 \times 6 \times 11$ cm plastic box divided into four compartments by three screens (3, 2, and 1 mm mesh) to estimate mean particle size. The BFS is a simple method developed by Danish researchers at the Bygholm Research Centre to immediately estimate particle size in a feed mill. In Exp. 1, mean particle size of 30 ground corn samples were evaluated using the BFS operated according to manufacturer's directions. Samples were analyzed without balls or with two rubber balls placed on the 2 mm screen and one ball placed on the 1 mm screen. Samples also were analyzed with a Ro-Tap 13-sieve stack (53 to 3,350 Mm Tyler mesh screens) according to ASAE methods. Particle sizes ranged from 543 to 1,082 Mm using the Ro-Tap. Adding the balls to the BFS did not improve the accuracy of the prediction equations ($R^2 = 0.80$ vs. 0.82). Thus, all subsequent analyses were conducted without balls. In Exp. 2, 25 additional ground corn samples (604 to 1,741 Mm) were analyzed to validate the linear regression equation developed in Exp. 1. Results indicated that 90% of particle size values were predicted within 100 Mm of the particle size when the samples were less than 1,000 Mm; however, only 69% of samples with large particle sizes ($> 1,000$ Mm) were predicted within 100 Mm. Adding quadratic terms to a model using all samples allowed development of a more robust regression equation to predict particle size using the BFS method (particle size, Mm = $-1172 + 69.709w + 25.297x + 0y + 25.518z - 1.173w^2 + 0.1151x^2 + 0.2139y^2 - 0.055z^2$, where w, x, y, and z are the percentages of the sample above the 3, 2, 1 mm screens and base, respectively; $R^2 = 0.92$). This equation predicts that 85% of the samples evaluated using the BFS will be within 100 Mm of the Ro-Tap method particle size and 98% of all samples to be within 150 Mm. These results indicate the BFS is a low cost method to estimate particle size in feed mills.

Key Words: Particle size, Corn

32 Effects of estradiol on the uterine environment and trophoctoderm in the gilt. T. Wilmoth*, D. Smith, J. Koch, and M. Wilson, *West Virginia University, Morgantown*.

In the pig, it has been suggested that the size of the placenta during late gestation is influenced by the size of the embryo at elongation. Treat-

ment of Meishan gilts with estradiol at the time the embryo is producing estradiol and elongating, caused a dramatic increase in placental size. The objectives of the current experiment were to determine how estradiol treatment during elongation would alter the uterine luminal environment and what effect, either directly or indirectly, that estradiol would have on the rate of trophoctoderm proliferation. We utilized commercial crossbred gilts ($n=12$) which were checked for estrous behavior twice daily for at least two normal cycles (17-22 days). Each gilt was then bred by AI at 12 and 24 h following the onset of estrus. Beginning on day 12, half of the gilts were randomly assigned to receive estradiol (1 mg) every 6 h. On day 14, embryos and the associated uterine flushings were collected. Embryos were fixed and embedded in paraffin for later determination of trophoctoderm proliferation. Uterine flushings were clarified by centrifugation and snap frozen for later determination of the concentrations of estradiol, IGF-I, prostaglandin (PG) F2A, and PGE2. Trophoctoderm proliferation was determined by sectioning the embryos at 10 Mm and immunohistochemically staining them for proliferating cell nuclear antigen (PCNA) and counterstaining with hematoxylin. The proportion of PCNA positive nuclei in four fields were then determined. Treatment of gilts with estradiol increased the uterine luminal content of PGE2 ($P=0.059$) and PGF2A ($P=0.085$) compared to control gilts. The proportion of PCNA positive cells in the trophoctoderm of embryos collected from gilts that were treated with estradiol were approximately 33% greater than those from control treated gilts. It appears that the dramatic increase in placental size at term following administration of estradiol during elongation may be a result of an indirect effect of estradiol on the rate of proliferation of the trophoctoderm.

Key Words: Estradiol, Trophoctoderm, Uterine environment

33 Milk production and pregnancy rate of dairy cows in an *in-vitro* fertilization embryo transfer program. L. E. Rensink*, J. D. Helmus¹, D. C. Arnett¹, J. S. Metzger², G. W. Robinson², and A. N. Scheaffer¹, ¹*Northwestern College, Orange City, IA*, ²*Trans Ova Genetics, Sioux Center, IA*.

An embryo transfer program in production dairy cows offers a reproductive management technique to offset artificial insemination. We are working in collaboration with Trans Ova Genetics (TOG) investigating procedures that would make embryo transfer of IVF embryos available to the dairy industry. At this writing, TOG has transferred 4928 embryos with a 28-d pregnancy rate of 34.7%, while the expected pregnancy rate in lactating dairy cows with AI is 20 to 25%. Estrous was synchronized with OvSynch and was selected as a recipient after rectal palpation and ultrasonographic examination of ovarian structures. When examining the complete set of cows that were in the ET program cows and diagnosed as pregnant at d 28 produced less milk and were fewer DIM (75 vs. 72 lbs and 180 vs. 215 d respectively). A subset of this group ($n = 91$) was examined at one farm and no difference was detectable, however, a numerical decrease in DIM was observed. Body condition score was evaluated at the time of implant and 28-d later. BCS at the time of implant for cows that were pregnant at d 28 was 2.86 and those that did not become pregnant had a similar BCS of 2.84. Yet, at the d 28 palpation exam the cows that established a pregnancy had an average BCS of 2.93 and the non-pregnant cows had a numerically lower BCS of 2.81. This data indicates that cows that establish pregnancy from an ET program are similar in condition, produce less total milk, and are earlier

in the lactation cycle than cows that do not become pregnant. These data warrant further investigation to select the recipient most likely to establish a pregnancy resulting in the delivery of a healthy neonate.

Key Words: Dairy cows, Milk production, Embryo transfer

34 Supplementing of grazing dairy cows with fish oil and sunflower oil enhances milk conjugated linoleic acid without affecting cows performance. L. Holmes*¹, A. AbuGhazaleh¹, G. Apgar¹, and K. Griswold², ¹*Southern Illinois University, Carbondale*, ²*Pennsylvania State University, Lancaster*.

The objective of this study was to determine the effect of adding fish oil (FO) and sunflower oil (SFO) to grazing dairy cows diet on milk conjugated linoleic acid (CLA) and cows performance. Fourteen Holstein cows (105 ± 19 DIM) were fed a TMR (50:50) diet for 1 wk then divided into 2 groups (7 cows/treatment) and offered fat supplements for 3 wk while in pasture. Cows in group one were fed a basal diet (7.5 kg DM basis) consisting of corn, soybean meal, molasses, vitamin/mineral premix plus 500 g animal fat (CONT). Cows in the second group were fed the basal diet plus 100 g of FO and 400 g of SFO (FOSFO). Cows were milked twice a day and milk samples were collected every 3 days. Both groups grazed together on a fresh pasture for ad libitum and fed treatment diets after the morning and afternoon milking. Milk production (32.7 and 33.0 kg/d), milk fat percentages (3.8 and 3.8), and milk fat yield (1.25 and 1.24 kg/d) for diet 1 and 2, respectively, were not affected ($P > 0.05$) by treatment diets. Compared with CONT, milk protein percentages (3.0 and 2.9) were lower ($P < 0.05$) with FOSFO diet, but milk protein yield (1.0 and 1.0 kg/d) was not affected ($P > 0.05$) by treatment diets. The concentrations of cis-9 trans-11 CLA (0.77 and 1.41 g/100g fatty acid) and vaccenic acid (2.14 and 4.76 g/100g fatty acid) in milk fat were higher ($P < 0.05$) for cows fed the FOSFO over the 3 wk of fat supplementation. The concentration of cis-9 trans-11 CLA in milk fat reached maximum (0.84 and 1.59 g/100g fatty acid for diets 1 and 2, respectively) on day 6 with both diets and remaining relatively constant thereafter. The concentration of vaccenic acid in milk fat followed the same pattern of temporal changes as cis-9 trans-11 CLA. In conclusion, supplementing grazing cows diet with FO and SFO enhances milk cis-9 trans-11 CLA content and that increase remains relatively constant after day 6.

Key Words: Grazing, Fish oil, CLA

35 Survey of beef consumers in the Fargo, North Dakota market: Interest in natural and source identified beef. K. A. Cook*^{1,2}, G. P. Lardy¹, K. R. Maddock Carlin¹, T. D. Maddock¹, M. J. Marchello¹, and K. G. Odde¹, ¹*North Dakota State University, Fargo*, ²*Michigan State University, East Lansing*.

In order to characterize beef customer preferences, buying habits and the potential demand for a natural or source branded beef product from North Dakota, a survey of 1,200 grocery customers in Fargo, ND and Moorhead, MN was conducted. The survey consisted of three parts: 1) optional demographic questions concerning age and income; 2) questions pertaining to shopping habits including grocery shopping frequency, preferences, and beef buying habits; and 3) customer interest in a beef product that was labeled either “natural” or “raised in ND.”

Surveyors verbally solicited customers to complete the survey at four supermarkets (Hornbacher's Foods, Fargo, ND; 3 in Fargo, ND and 1 in Moorhead, MN). Frequency distributions were generated for each question using PROC Freq of SAS (Cary, NC). The survey found that customer age and annual household income were widely dispersed. The female head of the household was the primary shopper for groceries (69.1%) and 33.9 percent of the customers indicated that they shopped for groceries twice a week. Most customers ate beef three times a week (34.2%) and 57.2% purchased beef once a week. Additionally, 47.5% of customers waited for beef to go on sale before purchase. Most customers (66.8%) used the service counter for less than 20% of their beef purchases. A large portion (75.9%) of beef customers polled responded that they would be inclined to purchase a beef product labeled “raised in ND” and 71.2% indicated they were willing to pay a five percent or greater premium for a “raised in ND” beef product. Additionally, 37.8% of beef customers indicated they would be interested in purchasing a “natural” beef product and 61.9% of the customers responded that they would be willing to pay a five percent or greater premium for a beef product labeled “natural.” As a result, the ND beef industry should consider exploring options related to a branded beef product labeled “raised in ND” in order to capture more customers and generate more value for beef.

Key Words: Beef, Survey, North Dakota

36 The effects of myostatin on skeletal muscle re-growth following disuse atrophy in mice. M. Grant*, J. Koltes, and J. Reecy, *Iowa State University, Ames*.

Myostatin is an inhibitor of muscle growth. Mutations in cattle, mice and humans create a double muscled phenotype. Muscle re-growth is an important issue in both human and animal health. The objective of this study was to evaluate the effects of myostatin on skeletal muscle re-growth following disuse atrophy. Both female (n=19) and male (n=16) myostatin-null and wild-type mice were used in a hind limb suspension experiment. Hind limb suspension results in atrophy of weight bearing muscles. After 10 days of hind limb suspension, skeletal muscle (gastrocnemius, extensor digitorum longus (EDL) and soleus) was collected from half of the mice. The remaining mice were allowed to resume normal ambulatory activity for 21 days after which skeletal muscle samples were collected. Muscles were flash frozen in liquid nitrogen. Body weights were collected throughout the experiment. Skeletal muscles were analyzed for total weight, DNA, RNA and protein content. The ratios of RNA/DNA, Protein/RNA, and Protein/DNA were used as indicators of transcription, translation and hypertrophy, respectively. Results indicate that myostatin-null mice had heavier muscle and body weight, including a strong sex effect ($P < .003$). No day effects (day 10 compared to day 31) were observed in myostatin null mice ($P < .8729$). Skeletal muscle mass recovered in the gastroc and soleus of wild-type mice ($P = .0101$), which was in direct contrast to the lack of muscle weight recovery observed in myostatin-null mice ($P < .9427$). Sex effects were observed for total DNA and transcription ($P < .0566$). Day effects were observed for total DNA, total RNA and translation ($P < .0298$). No main effects were observed for total protein ($P < .6611$), transcription ($P < .6565$) or hypertrophy ($P < .4870$). These results indicate that skeletal muscle mass in myostatin-null mice is sufficient to bear weight load, eliminating the need for muscle recovery or re-growth. Alternatively, muscle re-growth in myostatin-null mice may be impaired in aged mice.

37 Hormone concentrations of production dairy cows in an *in-vitro* fertilization embryo transfer program. J. D. Helmus*¹, L. E. Rensink¹, D. H. Keisler², D. C. Arnett¹, J. S. Metzger³, G. W. Robinson³, and A. N. Scheaffer¹, ¹*Northwestern College, Orange City, IA*, ²*University of Missouri, Columbia*, ³*Trans Ova Genetics, Sioux Center, IA*.

An embryo transfer program in production dairy cows offers a reproductive management technique to offset artificial insemination. We evaluated total number of CLs, total CL diameter (mm), progesterone (ng/ml), leptin (ng/ml), and IGF-1 in 88 cows on a single farm to evaluate whether these variables could be used to optimize the selection of recipient cows. We are working in collaboration with Trans Ova Genetics (TOG) investigating procedures that would make embryo transfer of IVF embryos available to the dairy industry. We have been able to improve the pregnancy rate of production dairy cows up to 35% at 28-d. The farm that is involved with this ET program is a production dairy farm that manages cows under standard industry practices. All cows involved in this experiment had estrous synchronized with OvSynch. A rectal and ultrasonographic exam of ovarian structures was done on the day of ET. Cows with a corpus luteum diameter of 10 mm or greater had an embryo transferred to them. We observed a numerical increase in the number of corpus lutea in cows that were pregnant at d 28. There was a numerical decrease in IGF-1 concentration in the pregnant compared to non-pregnant cows. We also noted a numerical increase in CL diameter, progesterone and leptin concentration. In our observations, there were not any significant differences between cows that were pregnant or non-pregnant 28-d after embryo transfer.

Key Words: Dairy cows, Progesterone, Leptin

38 Effects of level and source of selenium on maternal jejunal vascularity in growing pregnant ewe lambs. S. Julius*¹, M. Ward¹, J. Caton¹, J. Taylor², S. Soto-Navarro³, K. Vonnahme¹, T. Neville¹, J. Reed¹, P. Borowicz¹, D. Redmer¹, and L. Reynolds¹, ¹*North Dakota State University, Fargo*, ²*USDA-ARS Sheep Experiment Station, Dubois, ID*, ³*New Mexico State University, Las Cruces*.

Pregnant Targhee ewe lambs (n = 32; BW = 45.6 + 2.3 kg) were randomly allotted to one of four treatments in a completely randomized design to examine effects of dietary Se source and level on maternal jejunal vascularity. Ewes received diets containing (DM basis) either no added Se (CON) or supranutritional Se added as high Se-wheat at 3.0 ppm (SW) or sodium selenate at 3 (S3) or 15 (S15) ppm Se. Diets were similar in CP (15.5%) and energy (2.68 Mcal), and fed to meet or exceed requirements. Treatments were initiated at 50 ± 5 d of gestation. The CON, SW, S3, and S15 treatment diets provided 2.5, 75, 75, and 375 mg/kg BW of Se, respectively. On day 134 ± 10 of gestation, ewes were slaughtered and tissues harvested. There were no differences in initial and final ewe BW. Maternal jejunal mucosal DNA concentrations (mg/g) and contents (g) were greater (P < 0.09) in SW compared with all other treatments. Total number of proliferating crypt cells in maternal jejunal mucosa were greater (P < 0.02) in Se-fed ewes compared with CON. Capillary area density (capillary area/unit tissue area) was not altered by treatment. Capillary number density (capillary number/unit tissue area) was greater (P = 0.01) in maternal jejunum of S15 compared with SW and control ewes, and was greater (P < 0.09) in S3 and S15 compared with SW treated ewes. Capillary surface area was not affected by treatment; however, size (cross-sectional area) per capillary tended (P = 0.14) to be smaller in ewes fed S3 and S15 compared with controls.

These data indicate that capillary structure of maternal jejunal villi is altered by dietary Se, and that source and level of Se may be important contributing factors to these changes.

Key Words: Intestine, Selenium, Vascularity

39 Effects of maternal undernutrition and high selenium (Se) on mammary gland growth in late pregnant sheep. P. Nester*^{1,2}, J. Reed^{1,2}, D. Redmer^{1,2}, L. Reynolds^{1,2}, K. Vonnahme^{1,2}, and J. Caton^{1,2}, ¹*Center for Nutrition and Pregnancy, Fargo, ND*, ²*North Dakota State University, Fargo*.

To determine the effects of Se and nutrition on mammary mass and cellular proliferation in pregnant ewe lambs, 64 Targhee ewes were randomly allotted to one of eight treatments. At breeding, ewes were assigned to normal Se (NSe; 0.3 ppm Se) or high Se (HSe; 3.0 ppm Se) diets. Se supplement was formulated using a Se yeast product. Each diet was similar in CP (13.8%) and ME (2.66 Mcal/kg). Ewes were fed 100% NRC requirements until d 50 of gestation. On d 50, ewes within each Se group were assigned to one of four nutritional levels for the remainder of pregnancy: Group 100/100 received 100% NRC from d 50 to d 130; Group 60/60 received 60% NRC from d 50 to d 130; Group 60/100 received 60% NRC from d 50 to d 90, thereafter 100% NRC from d 90 to d 130; and Group 100/60 received 100% NRC from d 50 to d 90 thereafter 60% NRC from d 90 to d 130 of gestation. One hour before necropsy (d 130 ± 3 of gestation), ewes were injected with BrdU. Mammary glands were weighed and then fixed with Carnoy's solution by vascular perfusion, embedded in paraffin, sectioned, and stained with anti-BrdU for cell proliferation. Data was evaluated for effects of Se level, nutritional level, and their interaction on mammary weight; DNA, RNA, and protein concentration; DNA:RNA and protein:DNA content; RNA:DNA and protein:DNA. There was no Se effect but there was a nutritional effect (P < 0.05) on mammary weight, with 100/60 and 60/60 groups having lighter mammary weights than 100/100 and 60/100 groups. While there was no nutritional impact in HSe ewes on protein concentration, NSe 60/60 ewes had increased (P < 0.05) protein concentration compared with NSe 100/60 or 60/100. There was no effect of Se or nutritional levels on protein content. Mammary RNA content and concentration were increased in ewes (P < 0.05) fed HSe 60/100 compared with all other groups. No effects of Se or nutritional level on cellular proliferation, RNA:DNA, protein:DNA, or DNA concentration or content were seen. Data indicate that high levels of Se or undernutrition affect mammary weight, protein concentration, and cellular activity. Supported by USDA CSREES NRI Grant 2005-35206-15281.

Key Words: Mammary gland, Selenium, Undernutrition

40 Effects of energy restriction during gilt development on growth, backfat, longissimus muscle development and age at puberty. E. Maricle*, P. Miller, and R. Johnson, *University of Nebraska, Lincoln*.

Growth, rates of backfat (BF) and longissimus muscle area (LMA) deposition, and pubertal development in gilts with ad libitum access to feed or restricted energy intake during development are reported. The

long-term objective is to determine if energy restriction affects longevity and lifetime productivity of prolific gilts that differ in lean growth rate. Gilts were progeny of maternal L_M boars mated with females of either the UNL Large White-Landrace population (LW x LR, $n = 80$) or of a UNL line selected 22 generations for increased litter size (L45X, $n = 80$). Gilts were allowed ad libitum access to diets that met NRC requirements until 123 d of age when they were randomly assigned within litter to treatments. Gilts (40 per line) were allowed ad libitum access to feed or were restricted to 75% of ad libitum intake until breeding age. Diets provided similar daily intake of all nutrients except energy. Traits were recorded at 14-d intervals beginning at 56 d (BW and feed intake) or 123 d (10th-rib BF and LMA) to 235 d. Heat checking began at 140 d of age. Data were analyzed with quadratic regression models accounting for random litter effects. The LW x LR gilts were 6.2 ± 3.0 d younger than L45X gilts at puberty ($P = 0.04$). Diet did not affect age at puberty, but an interaction existed ($P = 0.04$); LW x LR gilts with restricted intake were 5.4 ± 4.0 d younger than those with ad libitum access to feed, whereas L45X gilts with ad libitum access to feed were 6.1 ± 3.9 d younger than those with restricted intake. The LW x LR gilts grew faster than L45X gilts ($P < 0.0001$), being 9.6 ± 2.2 kg heavier at 235 d; but BF and LMA relative to BW did not differ. Restricting energy intake reduced BF ($P < 0.0001$) similarly in both populations (10.0 ± 1.1 mm at 235 d). Longissimus muscle area relative to BW was not affected by nutritional regimen. Restricting energy intake during gilt development reduced growth rate and rate of BF deposition with little effect on LMA per kg of BW. Further research will evaluate effects on reproduction and longevity.

Key Words: Pigs, Growth, Feed restriction

41 The use of infrared thermography of the eye to assess pain in lame dairy cows. J. R. Crossgrove*, B. A. Munsell, and A. J. Zanella, *Michigan State University, East Lansing.*

Lameness and the associated pain impacts the dairy industry because of its effects on productivity and animal welfare. Previous attempts to objectively assess pain in cattle have been unsuccessful. Current lameness and pain detection protocols include gait scoring, force and pressure plates and inspection at hoof trimming. Infrared thermography (IRT) of the eye has been previously used to detect fear and stress in cattle and in the early detection of bovine respiratory disease. The objective of this study was to examine whether IRT of the eye (eye temperature) would be a reliable way to assess pain in lame dairy cattle. We hypothesize that lame cows will show higher eye temperature than sound cows and asymmetry in temperature between the left and right eye. In this study, 15 sound and 15 lame Holstein cows were studied. Cows were selected based on parity and locomotion score. All cows were in their second or third lactation and were less than 40 d in milk. Digital and thermal images were taken of both the right and left eyes once a day for eleven consecutive days. On day six of the study, cows' hooves were trimmed and all lesions were recorded. Images of the eye were taken at a distance of approximately 1 m. Differences in eye temperature were analyzed using a T-test to compare means. There was no difference ($P = 0.126$) in eye temperatures between lame (37.08 ± 0.030) and sound (37.148 ± 0.032) cows, no difference ($P = 0.686$) in eye temperatures between cow with lesions (37.122 ± 0.031) and those with no lesions (37.104 ± 0.031), and no difference between left and right eye temperatures in sound ($P = 0.431$) and lame ($P = 0.607$) cows.

These results suggest that using IRT of the eye to assess pain associated with lameness in dairy cattle would be ineffective.

Key Words: Infrared thermography, Lameness, Eye temperature

42 Effect of egg protein antibody on performance of dairy calves. R. Schnobrich*¹, H. Chester-Jones², D. Ziegler², R. Larson³, B. Ziegler³, and J. Linn¹, ¹University of Minnesota, St. Paul, ²University of Minnesota, Waseca, ³Hubbard Feeds, Mankato, MN.

This study was conducted to determine if a protein antibody (IgY) preparation derived from eggs produced by chickens vaccinated with bovine rota, corona, E. coli-K99 and cryptosporidia antibodies affected the growth and scouring of calves during the first two months of life. Forty heifer calves, born on 3 commercial dairies, were transported to the SROC between 2 to 5 d of age and randomly assigned to 1 of 2 treatments by farm source for a 56 d feeding study. Treatments were control (C) at 0 grams or 9 grams per d of an egg protein antibody (EA) preparation in the AM milk replacer for the first 28 d. All calves were fed 0.28 kg of a 20% CP; 20% fat milk replacer mixed into 2 kg of water twice daily for 35 d and then once daily until weaning at 42 d. Water and calf starter (18% CP) were available free-choice throughout the study. Data collection on individual calves included: serum protein concentration; body weights (BW) on arrival, d 14, 28, 42 and 56; daily feed intake and daily fecal scores. All calves were housed individually in pens. Growth and intake data were analyzed using PROC MIXED (significance = $P < .05$) with initial BW as a covariate. Serum protein was similar across treatments averaging 5.5 g/dl. There was no difference in BW at d 14, 28, 42 or 56 or total weight gained through 56 d with C calves gaining 41.2 kg compared to 40.1 kg for EA calves. Egg protein antibody did not affect the consumption of milk replacer with an average intake of 20.5 kg DM through weaning. However, EA calves consumed less starter than C calves during the 56 d study (49.4 vs. 53.9 kg). There was a tendency ($P = .11$) for egg protein antibody to increase feed efficiency averaging 0.58 kg BW gain/kg DMI through 56 d compared to 0.55 for control. Daily fecal scores (1 = normal; 4 = very watery) for the 56 d averaged 1.53 and 1.56 for C and EA, respectively. In summary, IgY did not affect performance or fecal consistency of calves during the first two months of life.

Key Words: Dairy calves, Milk replacer, Egg protein antibody

43 Assessing farm owners' attitudes and perceptions about lameness of dairy cattle. A. M. Edgecomb*, C. L. Wickens, and D. K. Beede, *Michigan State University, East Lansing.*

Previous research showed that lameness reduces productivity and welfare of the dairy cows. Because management strategies have been suggested to reduce lameness, it was thought that a better understanding of the perceptions of dairy farmers would provide insight. Therefore, perceptions of dairy farmers were studied using a Survey instrument sent to 1,280 Michigan dairy farmers. Survey return rate was 30.5%. The data were analyzed using SPSS® and the Bernoulli proportion tests. Majority (53%) of farmers indicated less than 10% incidence of lameness and 60% did not believe lameness was a problem in their herds. Moreover, farmers indicated that they not use a specific method for documenting lame cows (69%). Additionally, 77% of owners were the

main person responsible for managing lameness, and in 39% of farms there was lack of a team-approach to manage lameness. And finally, 40% of farmers did not employ a professional hoof trimmer. We conclude that impacts of lameness on productivity and animal welfare may be misunderstood and underestimated, so further educational and research programs should be pursued.

Key Words: Lameness, Animal welfare, Attitudes

44 Effect of moisture enhancement on sensory attributes, tenderness, and retail color of beef steaks from the *gluteus medius*.

M. D. Vieson^{*1}, P. S. Kuber¹, H. N. Zerby¹, A. E. Radunz¹, S. J. Moeller¹, J. L. Bard¹, A. C. Naber¹, K. M. Brueggemeier¹, G. R. Dunlap¹, and B. L. Gwartney², ¹The Ohio State University, Columbus, ²National Cattlemen's Beef Association, Centennial, CO.

Retail color, palatability, and tenderness were evaluated on fresh moisture enhanced beef steaks removed from *gluteus medius* roasts. Roasts from USDA low Choice (n = 40) and low Select (n = 39) carcasses were divided in half by removing one control (CON) steak from the center to determine initial shear force. Each half received one of two treatments: 1) Brine injection (BI) pumped to 110% green weight (2.5% sodium

lactate, 0.35% sodium tripolyphosphate and 0.65% sodium chloride); or 2) needle tenderized (NT). Steaks (2.54 cm) were removed from BI and NT roasts for Warner-Bratzler shear-force (aged 7, 14, and 21 d) and for sensory analysis (aged 14 d). Subjective (5 d; 5-member panel) and objective color (8 d; L*, a* and b*) were measured on steaks under retail display lighting. Overall, BI steaks (2.85 kg) were more tender ($P < 0.0001$) than NT steaks (3.47 kg) and CON steaks (3.51 kg), NT and CON steaks did not differ. Drip and cooking loss were less ($P < 0.0001$) in BI than NT steaks suggesting improved water retention. Sensory evaluation revealed that BI steaks had more ($P < 0.0001$) initial tenderness and juiciness, sustained tenderness and juiciness, beef flavor and overall greater preference than NT steaks. Objective color readings indicated that BI steaks were initially (d 1) darker (L*), less red (a*) and less yellow (b*) ($P < 0.0001$) than NT steaks. However, the change between d 1 and 8 readings were greater ($P < 0.0001$) for L* and b* in NT versus BI steaks suggesting that retail color was more stable in moisture enhanced steaks. Subjective color panel data reported no differences ($P > 0.05$) due to treatment, implying that L* and b* differences measured in objective evaluation may not be visible to the consumer. These results indicate that moisture enhancement may improve sensory attributes, tenderness and water retention, while stabilizing color in the retail case.

Key Words: Beef, Moisture enhancement, Palatability

Animal Behavior, Housing, and Well Being

45 Effects of space allowance and weight group composition on the performance of grow-finish pigs on fully slatted floors. L. Anil*, S. S. Anil, and J. Deen, University of Minnesota, St. Paul.

A study (4×2 factorial design, 32 pens across two barns, fully slatted floor, ad libitum feed and water and Paylean in feed-9g/ton during last week of the trial) was conducted to evaluate ADG and pen efficiency (PE) of grow-finish pigs (in groups of 19 barrows), at four levels of floor space allowances calculated allometrically ($\text{area m}^2 = k \times \text{BW}^{0.667}$) using k values of 0.027, 0.031, 0.034, and 0.037 for final BW of 116 kg and in two levels of group BW composition (uniform or varying BW). The corresponding space allowances (m^2/pig) were 0.64 (S0.64), 0.74 (S0.74), 0.81 (S0.81), and 0.88 (S0.88). Contemporary k value for each pen (based on weekly BW and pen area), ADG (kg/d) and PE (ADG/ m^2 space) were determined. The contemporary k was categorized into five classes, < 0.030 (k1), 0.0301 to 0.0320 (k2), 0.0321 to 0.0340 (k3), 0.0341 to 0.360 (k4) and > 0.0360 (k5). The data were analyzed using repeated measures of ANOVA (for ADG and PE), one way ANOVA (for comparing CV% of BW) and linear regression (association of ADG with contemporary k, BW, BW composition, Paylean feeding and barns). The pigs in S0.64 had lower ($P < 0.05$) ADG than in S0.88 and S0.81. Pigs in S0.64 and S0.74 did not differ in ADG. The ADG's of pigs in S0.88, S0.81 and S0.74 were not different. ADG had positive associations with BW and a negative association with contemporary k < 0.030 ($P < 0.05$ for both). Pigs in both uniform and varying groups in S0.88 and S0.81 did not differ in CV% of BW at market weight. Pigs in S0.64 had higher ($P < 0.05$) overall PE (1.344 ± 0.0269) than those in S0.74, S0.81 and S0.88 (1.224 ± 0.0286 , 1.131 ± 0.024 and 1.063 ± 0.023 , respectively). Allotting grow-finish pigs according to uniformity or variation in BW did not provide differential benefit in ADG. On fully slatted floors, space allotted considering the final market BW of barrows corre-

sponding to k values of 0.037 and 0.034 performed better than 0.027. Performance of pigs appears to be adversely affected when the space allowance is based on a k value of 0.027 or less.

Key Words: Space allowances, Pigs, Grow-finish

46 Effects of space allowance and weight group composition on the welfare of grow-finish pigs on fully slatted floors. L. Anil*, S. S. Anil, and J. Deen, University of Minnesota, St. Paul.

Welfare indicators (behavior, salivary cortisol concentration and injury scores) of grower-finish pigs were evaluated (4×2 factorial design, 32 pens, fully slatted floor, ad libitum feed and water) in groups of 19 barrows, at four levels of floor space allowances calculated allometrically ($\text{area m}^2 = k \times \text{BW}^{0.667}$) using k values of 0.027, 0.031, 0.034, and 0.037 for a final BW of 116 kg and in two levels of group BW composition (uniform or varying BW). The corresponding space allowances (m^2/pig) were 0.64 (S0.64), 0.74 (S0.74), 0.81 (S0.81), and 0.88 (S0.88). Behavior data using video camera and time-lapse VCR (once in 2 wk), total injury scores (TIS) and saliva samples (once weekly for both) were collected from five randomly identified focal pigs from each pen when pigs reached a BW of 75 kg in any one of the pens. Salivary cortisol concentrations were assessed using radioimmunoassay. The data were analyzed using repeated measure ANOVA. Pigs in S0.64 had higher ($P < 0.05$) TIS than in S0.88 and S0.81. Average TIS were different ($P < 0.05$) across different time points. Aggressive interactions were higher ($P < 0.05$) in S0.64 than in S0.88 and S 0.81. There was no difference in TIS

and aggressive interactions between pigs in S0.74, S0.81 and S0.88 and between pigs in S0.64 and S0.74. Cortisol concentration was higher ($P < 0.05$) at initial stages of grow-finish period. Pigs in S0.64 spent a lower proportion ($P < 0.05$) of time lying in preferred areas (body supported on side walls of the pen rather than at the central area or near the feeder) than pigs in S0.88 and S0.81. Pigs in the varying BW group spent higher proportion of time lying in preferred areas ($P < 0.05$). Pigs in S0.74 and S0.64 spent lower proportion of time ($P < 0.05$) lying isolated than pigs in S0.81. Allotting grow-finish pigs according to uniformity or variation in BW did not provide significant benefit. The results suggest that the welfare of barrows housed on fully slatted floor is adversely affected when space is provided considering final market BW, corresponding to a k value of 0.027 in comparison to k values of 0.037 and 0.034.

Key Words: Behavior, Welfare, Pigs

47 Evaluating finishing pig growth, loin muscle area, and backfat accretion during summer and winter for bedded hoop and confinement barns. J. R. Morrical, M. S. Honeyman*, J. D. Harmon, T. J. Baas, and C. R. Schwab, *Iowa State University, Ames.*

Growth and development of finishing pigs in bedded hoop and confinement barns during summer and winter was evaluated using serial ultrasound measurements of backfat (BF) thickness and loin muscle (LM) area, and serial weighing. Forty eight pigs each from the hoop barn and the confinement barn were randomly selected and weighed and ultrasound images recorded every 14 d during the last 56 d of the finishing phase. BF accretion rates were greater for summer hoop pigs (SH) than summer confinement pigs (SC) at 80 kg (0.17 vs. 0.13 mm/d), 85 kg (0.17 vs. 0.13 mm/d), and at 90 kg (0.18 vs. 0.13 mm/d) ($P < 0.05$), but did not differ at 95 to 115 kg. In winter, BF accretion rates did not differ from 80 to 105 kg, but winter hoop pigs (WH) had less BF accretion than winter confinement pigs (WC) at 110 kg (0.10 vs. 0.18 mm/d) and 115 kg (0.09 vs. 0.21 mm/d) ($P < 0.05$). LM accretion rates did not differ at 80 and 85 kg or from 100 to 115 kg, but were less for SH than SC at 90 kg (24 vs. 35 mm²/d) and at 95 kg (22 vs. 34 mm²/d) ($P < 0.001$). WH had greater LM accretion rates than WC at 80 kg (53 vs. 34 mm²/d), 85 kg (51 vs. 36 mm²/d), 90 kg (49 vs. 37 mm²/d), 95 kg (48 vs. 37 mm²/d), 100 kg (47 vs. 35 mm²/d), 105 kg (46 vs. 32 mm²/d) and 115 kg (46 vs. 21 mm²/d) ($P < 0.05$). Bodyweight gain (BWG) did not differ between SH and SC from 80 to 95 kg and was greater for SH at 100 kg (928 vs. 837 g/d), 105 kg (984 vs. 837 g/d), 110 kg (1051 vs. 872 g/d) and at 115 kg (1130 vs. 899 g/d) ($P < 0.05$). BWG did not differ for WH and WC pigs from 100 to 115 kg, but was less for WH than WC at 80 kg (681 vs. 869 g/d), 85 kg (691 vs. 861 g/d), 90 kg (713 vs. 858 g/d) ($P < 0.001$), and 95 kg (746 vs. 860 g/d; $P < 0.05$). Results indicate that performance of finishing pigs is dependent on thermal environment, and that hoop-reared pigs (particularly in winter) may compensate for a lag in performance early in the finishing period with greater accretion rates of LM and BW and lower accretion rates of BF later in the finishing period.

Key Words: Finishing pigs, Pig growth, Bedded hoop barns

48 Effects of crossfostering on growth rate and within litter variability at weaning. D. N. Peters*, L. J. M. Jönsson, C. Pedersen, and H. H. Stein, *South Dakota State University, Brookings.*

It was the objective to test the hypothesis that crossfostering of nursery pigs will reduce the within litter variability of pigs at weaning. The experiment was conducted as a 2 x 3 factorial with two litter sizes (nine or 12 pigs) and three strategies for creating litter weights (light, heavy, or variable). A total of 107 litters were included in the experiment and all cross fostering took place within 48 h after birth. The light and the heavy litters were created by creating litters consisting of pigs with a similar BW whereas the variable litters consisted of a mixture of light and heavy pigs. For the litters with nine pigs, initial BW were 1.17 ± 0.2 , 1.80 ± 0.21 , and 1.49 ± 0.38 kg for light, heavy, and variable groups, respectively. For the litters with 12 pigs, initial BW were 1.20 ± 0.21 , 1.81 ± 0.22 , and 1.50 ± 0.39 kg for light, heavy and variable groups, respectively. The initial BW were different ($P < 0.001$) among the three weight groups, but within each group, they were similar across the two litter sizes. Individual BW were recorded on d 7, 14, 21, and 28 and the SE and the coefficient of variation (CV) of the BW were calculated within each group. Results of the experiment showed that the differences in BW among the light, heavy, and variable groups remained constant throughout the experiment and the ADG for pigs were not influenced by the weight groups. However, pigs raised in litters with nine pigs were 390 g heavier ($P < 0.001$) at weaning compared with pigs raised in litters with 12 pigs. Within each litter size, the SE and CV for the variable group was greater ($P < 0.001$) on the day of cross fostering than the SE and the CV for the light and the heavy groups. However, at d 14, 21, and 28, no differences in SE or CV were observed among treatment groups within each litter size. It is concluded from the present experiment that the use of cross fostering to create litters consisting of pigs with a uniform BW at birth does not reduce the variability in BW among litter mates at weaning.

Key Words: Crossfostering, Pigs, Variability

49 Using sow lifts to reduce piglet crushing. R. Walker* and S. Baidoo, *University of Minnesota, Waseca.*

The biggest cause of piglet death during the first few days of life is crushing by the sow. In an effort to reduce this crushing mortality, a special farrowing crate was devised (Crystal Spring Hog Equipment Company, Ste. Agathe, MB, Canada) that elevates the sow section of the crate when she stands up. This greatly reduces the number of piglets beneath her when she lies back down. In a room of 16 farrowing crates, eight crates were converted to sow lifts (Lift) and eight were left as they were (Control). All 16 crates had anticrushing bars that made the sow lie down more slowly. A total of 175 sows (88 Lift and 87 Control) were monitored for lactation performance. Cross fostering to make uniform litter sizes was performed at random between and within treatments. Comparisons were made by t-test. There was no significant difference between Control and Lift in parity (5.2 vs 5.1); number born alive (10.3 vs 10.3); weaning age (19.1 d vs 19.0 d); number weaned (9.4 vs 9.5); and litter weaning weight (59.7 kg vs 59.4 kg). However, the number of pigs laid on per litter between Control and Lift sows was 0.34 vs 0.14 ($P = 0.01$), and piglet mortality rate between Control and Lift litters was 11.0% vs 8.1%, ($P = 0.12$). The data suggest that sow lifts may reduce mortality and help to prevent piglet crushing.

Key Words: Sow lifts, Crushing, Piglet

50 Environmental factors affecting feed intake of steers in different housing systems. H. Koknaroglu¹, Z. Otles², T. Mader³, and M. P. Hoffman*⁴, ¹*Suleyman Demirel University, Isparta, Turkey*, ²*Frontier Science and Technology Research Foundation, Madison, WI*, ³*University of Nebraska, Lincoln*, ⁴*Iowa State University, Ames*.

Yearling steers of predominantly Angus and Hereford breeds, with mean BW of 298 kg, were fed from the end of April to the beginning of October to assess the effects of environmental factors on feed intake of steers in various housing systems. Housing consisted of outside lots with access to overhead shelter, outside lots with no overhead shelter and a cold confinement building. Ad libitum corn, 2.27 kg of 35% DM whole plant sorghum silage, and 0.68 kg of a 61% protein-vitamin-mineral supplement was offered. Orts were measured to determine feed intake. The temperature data were recorded by hygro-thermographs. Temperature data were recorded at 2-hr intervals, accurate to approximately 0.5°C. Daily relative humidity and temperature-humidity index (THI) were also determined. Regression analysis was used. Depending on the improvement in the r-square, number of variables in the model was determined. Cattle in confinement had lower DMI than those in open lots and in open lots with access to an overhead shelter ($P < 0.05$). Cattle in outside lots with access to overhead shelter had similar DMI compared to those in open lots ($P = 0.065$). Effect of heat was predominantly displayed in August in all three housing systems. In outside lot with access to overhead shelter, average and daytime temperatures were important factors in explaining variation in DMI, whereas in open lots, nocturnal, peak and average daily temperatures were important factors. In the confinement building, previous day's temperature and THI were the most important factors in explaining variation in DMI. Results show facility type effects heat stress levels experienced by feedlot cattle in the summer, which subsequently influences DMI. Cattle producers wishing to improve cattle feedlot performance should consider housing conditions providing less stress or more comfort.

Key Words: Housing, Dry matter intake, Heat stress

51 Partial reduction of fescue toxicosis during heat stress using a supplemental yeast cell wall polymer. R. M. Heilman*¹, P. A. Eichen¹, L. E. Wax¹, T. Bramble², G. E. Rottinghaus¹, and D. E. Spiers¹, ¹*University of Missouri, Columbia*, ²*Alltech, Inc., Nicholasville, KY*.

Fescue toxicosis is a major problem in cattle grazing endophyte-infected fescue in much of the United States. A primary symptom is an increase in core body temperature (Tcore) during summer that is due to reduced heat loss. Recent studies in our laboratory have focused on evaluating different compounds under controlled environmental conditions to determine their potential as treatments for fescue toxicosis. We have demonstrated that the rat is an excellent model for this initial evaluation. A study was done to test the impact of MTB-100 (Alltech Inc., Nicholasville, KY), a yeast cell wall product, on fescue toxicosis. Male rats ($n = 24$), implanted with telemetric temperature/activity transmitters, were randomly assigned to endophyte-free diet (E-), MTB E-, endophyte-infected diet (E+), or MTB E+. Rats were housed at thermoneutrality (TN; 21°C) during pretreatment and the first 7 d of treatment, followed by seven days of heat stress (HS; 31°C). Following HS, all rats were euthanized for blood collection and measurement of organ weights. As we have previously seen, rats fed E+ exhibited a progressively greater decrease in feed intake from TN ($P < 0.05$) to HS environments, but rats fed MTB E+ tended to have less reduction during HS. In comparison, E+ rats at TN grew at a similar rate to E- rats during HS to suggest a similar level of stress. Activity was not different at any point in the study. Average daily Tcore was not different for any treatment group at TN. During HS, E+ rats had higher Tcore than E- and E- MTB rats ($P < 0.05$). More importantly, rats treated with MTB E+ displayed Tcore values that were not different from E- treatment groups during HS. Rats fed E+ had decreased liver and spleen weights relative to body weight ($P < 0.0001$), with no MTB-100 effect. Traditional blood indicators of fescue toxicosis, such as reduced amylase and glucose levels ($P < 0.05$), were unaffected by MTB-100 treatment. The results suggest that MTB-100 is effective in reducing the hyperthermia associated with fescue toxicosis. But, a higher dose of MTB-100 may be needed to significantly improve feed intake, which is a more sensitive indicator of fescue toxicosis.

Key Words: Fescue toxicosis, Heat stress

Growth and Development, Muscle Biology, and Meat Science

52 Effects of moisture enhancement on tenderness, retail color, and sensory characteristics of beef triceps brachii. A. E. Radunz*¹, P. S. Kuber¹, H. N. Zerby¹, M. D. Vieson¹, S. J. Moeller¹, A. C. Naber¹, K. M. Brueggemeier¹, J. L. Bard¹, G. R. Dunlap¹, and B. L. Gwartney², ¹*The Ohio State University, Columbus*, ²*National Cattlemen's Beef Association, Denver, CO*.

Beef shoulder clod roasts from USDA low Choice ($n = 40$) and low Select ($n = 30$) carcasses were used to evaluate effects of moisture enhancement on tenderness, sensory characteristics and retail color. Each triceps brachii roast was divided into half by removing one control steak (CON) at d 3 postmortem (PM). Each half roast was subject to one of two treatments: 1) brine injection (BI) pumped to 110% of green weight (2.5% sodium lactate, 0.35 % sodium tripolyphosphate and 0.65% sodium chloride) or 2) needle tenderized (NT). Steaks (2.54 cm) were removed from BI and NT roasts and aged for Warner-Bratzler

shear force (WBS) (7, 14, and 21 d PM), for sensory panel (14 d PM) and for retail color (13 d PM). Retail color was evaluated daily under retail display lighting objectively for 5 d by a 5-member panel and subjectively for 8 d for L*, a*, and b*. Overall, WBS was less ($P < 0.0001$) for BI compared with NT steaks (2.67 vs 3.63 kg, respectively). Steaks from BI aged at both 14 and 21 d had less ($P < 0.0001$) WBS than both NT and CON steaks, and NT steaks were more tender ($P < 0.0001$) than CON steaks aged 21 d. Cooking and drip loss were less ($P < 0.0001$) across all time periods for BI compared with NT steaks. Steaks from BI had greater ($P < 0.0001$) initial and sustained tenderness as well as juiciness, beef flavor and overall acceptability values than NT steaks as evaluated by a 6-member trained panel. Objective color measurements indicated BI steaks were overall lighter (L*), less red (a*) and less yellow (b*) than NT steaks ($P < 0.0001$). Subjective color scores of retail display reported NT steaks were preferred ($P < 0.05$) on d 1, but by d 2 thru 5 BI steaks were preferred ($P < 0.05$)

suggesting slower retail color degradation for BI steaks. Moisture enhancement of beef tricep brachii improved tenderness, sensory attributes, and water retention, while appearing to sustain retail color.

Key Words: Beef, Moisture enhancement, Palatability

53 Effect of moisture enhancement on sensory attributes, tenderness, and retail color of beef steaks from the *rectus femoris*. P. S. Kuber^{*1}, A. E. Radnuz¹, M. D. Vieson¹, H. N. Zerby¹, S. J. Moeller¹, J. L. Bard¹, A. C. Naber¹, K. M. Brueggemeier¹, G. R. Dunlap¹, and B. L. Gwartney², ¹The Ohio State University, Columbus, ²National Cattlemen's Beef Association, Centennial, CO.

Fresh beef steaks removed from USDA low Choice (n = 40) and low Select (n = 40) *rectus femoris* roasts were measured for the effect of high pressure moisture enhancement on retail color, palatability, and tenderness. Roasts were divided in half by removing one control (CON) steak from the center to determine initial tenderness. Each half received one of two treatments: 1) brine injection (BI) pumped to 110% green weight (2.5% sodium lactate, 0.35% sodium tripolyphosphate and 0.65% sodium chloride); or 2) needle tenderized (NT). Steaks (2.54 cm) were removed from BI and NT roasts for Warner-Bratzler shear-force (aged 7, 14, and 21 d) and sensory analysis (aged 14 d). Subjective (5 d; 5 member panel) and objective color (8 d; L*, a* and b*) were measured daily on steaks under retail display lighting. Overall, BI (2.81 kg) steaks were more tender ($P < 0.0001$) than NT (3.78 kg) and CON (3.95 kg) steaks. No differences ($P > 0.05$) in tenderness between NT and CON existed. Drip and cooking loss were less ($P < 0.0001$) for BI vs NT, and BI vs NT and CON, respectively. Sensory evaluation revealed BI had more ($P < 0.0001$) initial tenderness and juiciness, sustained tenderness and juiciness, beef flavor intensity and overall acceptability than NT steaks. Objective color readings reported BI steaks were initially (d 1) darker (L*), less red (a*) and less yellow (b*) ($P < 0.0001$) than NT steaks, however change in L* and b* observed between d 1 and 8 readings was less ($P < 0.01$) in BI vs NT steaks implying BI steaks may be more stable in retail color. There was no reported difference ($P > 0.05$) in subjective panel color values suggesting L* and b* differences may not be visible in the retail case. These results suggest moisture enhancement may improve sensory attributes, tenderness, moisture retention and stabilize color during retail display.

Key Words: Beef, Moisture enhancement, Palatability

54 Effect of dietary fat source on fatty acid composition of backfat from growing-finishing swine. J. K. Apple^{*}, C. V. Maxwell, D. L. Galloway, S. Hutchison, and J. T. Sawyer, University of Arkansas, Fayetteville.

Crossbred pigs were used to test the effect of dietary fat source (FAT) on the fatty acid (FA) composition totals of backfat (BF) from growing-finishing swine. Pigs were blocked by BW, and, within blocks, pens (8 pigs/pen) were randomly assigned to corn-SBM diets with no fat (C) or diets containing 5% beef tallow (BT), poultry fat (PF), or soybean

oil (SBO). One pig from each pen (8 pens/treatment) was randomly selected for slaughter initially (22.7 kg) and at a mean pen weight (SWT) of 45.5, 68.1, 90.9, and 113.6 kg. Within 2 h of slaughter, a 4 × 6-cm backfat sample was removed from left sides immediately posterior to the scapula, and subsequently separated into inner, middle, and outer layers for fatty acid analysis. There were FAT × SWT interactions ($P < 0.001$) for total n-3, n-6, and trans FA, as well as the PUFA:SFA (P/S), n-6:n-3, and iodine values (IV). In all three BF layers, pigs fed SBO had greater proportions of n-3 and n-6 FA than other dietary treatments from 45.5 to 113.6 kg, whereas BT-fed pigs had the lowest percentage of n-6 FA at 68.1 and 90.9 kg. Even though n-6:n-3 was similar at 22.7 kg, n-6:n-3 increased in pigs fed C, BT, and PF from 45.5 to 113.6 kg, but decreased to the lowest values in SBO-fed pigs across the same weight range. Proportions of trans FA decreased as BW increased, and BF from pigs fed BT had more trans FA than pigs fed C, PF, and SBO between 45.5 and 113.6 kg. The P/S was greatest in SBO-fed pigs from 45.5 to 113.6 kg, whereas P/S values were similar among pigs fed C, PF, and BT and decreased with increasing BW. Moreover, IV of BF from SBO-fed pigs increased dramatically from 72.6, 73.36, and 74.4 at 22.7 kg to 83.9, 85.11, to 86.6 at 45.5 kg in the inner, middle, and outer BF layers, respectively. Moreover, IV of SBO pigs were greater than other dietary treatments from 45.5 to 113.6 kg, consistently greater than 80. Results indicate that feeding only 5% SBO greatly increases polyunsaturation of pork backfat, especially during the early growing phase, and markedly impacts pork quality.

Key Words: Dietary fat source, Iodine value, Pork backfat

55 Effect of dietary fat source on the polyunsaturated fatty acid (PUFA) composition of backfat from growing-finishing swine. J. K. Apple^{*}, C. V. Maxwell, D. L. Galloway, S. Hutchison, and J. T. Sawyer, University of Arkansas, Fayetteville.

Crossbred pigs were used to test the effect of dietary fat source (FAT) on the PUFA composition of backfat (BF) from growing-finishing swine. Pigs were blocked by BW, and, within blocks, pens (8 pigs/pen) were randomly assigned to corn-SBM diets with no fat (C) or diets containing 5% beef tallow (BT), poultry fat (PF), or soybean oil (SBO). One pig from each pen (8 pens/treatment) was randomly selected for slaughter initially (22.7 kg) and at mean pen weights (SWT) of 45.5, 68.1, 90.9, and 113.6 kg. Within 2 h of slaughter, a 4 × 6-cm sample of clearplate was removed from left sides immediately posterior to the scapula, and subsequently separated into inner, middle, and outer layers for fatty acid analysis. There were FAT × SWT interactions ($P < 0.001$) for linoleic (18:2), CLA, A-linolenic (18:3n3), and Γ -linolenic (18:3n6) acids, as well as total PUFA. Proportions of total PUFA increased substantially from 22.7 to 45.5 kg in SBO-fed pigs, and remained consistently greater than other treatments from 45.5 to 113.6 kg. Although similar initially (22.7 kg), percentages of 18:2 and 18:3n3 were increased in pigs fed SBO by 45.5 kg, and remained greater from 45.5 to 113.6 kg than for pigs fed C, PF, or BF. Percentages of 18:2 declined in BT-fed pigs, and remained unchanged in PF-pigs, whereas 18:3n3 were similar among pigs fed C, PF, and BT and did not change during the study. Although CLA percentages declined with increasing BW, BF from BT-fed pigs had more CLA than that from pigs fed PF, SBO, and C. Between 45.5 and 90.9 kg, pigs fed PF had greater percentages of 18:3n6 than the other dietary treatments; however, at 113.6 kg, 18:3n6 propor-

tions did not differ among treatments in the outer layer, and were greater in pigs fed PF than C, BT, and SBO in the inner and middle BF layers. Feeding 5% SBO elevates the proportion of PUFA in pork BF, and the associated increase in PUFA is greatest during the early-growing period.

Key Words: Dietary fat source, Polyunsaturated fatty acids, Pork backfat

56 Classification of pork loin based on intramuscular lipid content to predict sensory and texture of fresh pork. S. Lonergan*, K. Stalder, E. Huff-Lonergan, T. Knight, R. Goodwin, K. Prusa, and D. Beitz, *Iowa State University, Ames.*

The objective of this project was to determine the contribution of lipid composition to textural and sensory properties of fresh pork. Pigs (n=2009; from 306 sires and 1030 dams) from the 1991, 1992, 1994, and 2001 National Barrow Show Sire Progeny Test were used in this study. The test included purebred Berkshire (269), Chester White (175), Duroc (360), Hampshire (228), Landrace (196), Poland China (130), Spotted (195), and Yorkshire (456) barrows (1178) and gilts (831). Diets were uniform within test and across breeds. The halothane (Hal 1843TM) genotype was determined. Pigs were slaughtered at 105 kg body weight, and samples of the longissimus muscle were obtained from each carcass at the 10th rib. Star probe, sensory traits, lipid content, and fatty acid profile were determined on the longissimus muscle from each pig. A lipid classification was determined based on percent intramuscular lipid. Class 1 (n=423) contained between 0 and 1.99% lipid, Class 2 (n=778) between 2 and 2.99% lipid, Class 3 (n=461) between 3 and 3.99% lipid, Class 4 (n=198) between 4 and 4.99% lipid, Class 5 (n=71) between 5 and 5.99% lipid, and Class 6 (n=45) greater than 6% lipid. Data were analyzed using a mixed linear model including lipid classification, test, gender, halothane genotype, breed, and breed-by-gender interaction as fixed effects, with sire and dam within breed included as random effects. Lipid classification was significant in models for Star Probe, Sensory Tenderness and Sensory Chewiness, but not for Sensory Juiciness or Sensory Flavor. Relatively minor, yet statistically significant improvements in sensory scores were observed in Class 3 (Tenderness, 3.8; Chewiness, 2.8) compared to Class 2 (Tenderness, 3.7; Chewiness, 2.9). Lipid class means for Star Probe (6.47, 6.40, 6.26, 6.00, 6.18 and 5.63 kg for Classes 1-6) support the conclusion that increasing lipid content above 6% lipid will improve tenderness of fresh pork loin. It is concluded that factors other than lipid composition also contribute to variation in sensory and texture traits of fresh pork.

Key Words: Pork texture, Lipid, Sensory quality

57 Effects of breed, aging and muscle location on Warner-Bratzler shear force in beef *longissimus thoracis et lumborum*. A. Weaver*, T. Stewart, and D. Gerrard, *Purdue University, West Lafayette, IN.*

Beef tenderness is influenced by a myriad of factors both ante- and post-mortem. Among these influences, conflicting data persist on the impact of animal breed, aging and core location on Warner-Bratzler shear

force (WBSF) values. *Longissimus thoracis et lumborum* (LTL) samples were obtained from 136 A-maturity crossbred steers representing five sire breeds: Angus (A), Simmental (S), South Devon (D), Charolais (C) and Crossbred (X). Samples were cut into 2.54 cm steaks and assigned to one of four aging periods: 1 d, 7 d, 14 d, or 21 d. Steaks were cooked to an internal temperature of 71° C. Location-specific cores were removed from the medial and distal portions of the steak, and WBSF was evaluated. Breed significantly affected ($P = 0.05$) tenderness as South Devon-based cattle had more desirable ($P = 0.05$) tenderness values. Cores from the medial (top of the steak) and lateral (bottom of the steak) sections of the LTL differed ($P = 0.001$), with lateral portions of the steak being more tender than the medial portion. Moreover, core samples from both the medial and lateral sections of steaks aged 1d were significantly tougher ($P = 0.0001$ and $P = 0.001$, respectively) than 7, 14 or 21 d aging periods. An interaction between aging period and core location, however, was not observed. No significant differences in tenderness were attributed to differences in rib eye area or USDA quality grade. Results of this study show that WBSF values vary with core sampling location in the LTL and this variation does not change with aging. Collectively, these data suggest that these differences are inherent to the steak and may be related to a differential physical stretching of the muscle or changes in connective tissue characteristics.

Key Words: Beef, Tenderness, Warner-Bratzler shear force

58 Fetal growth of lambs paternally heterozygous for the *callipyge* mutation. H. C. Freely*¹, M. B. McDonagh², and C. L. Ferrell¹, ¹USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE, ²Department of Primary Industries, Victoria, Australia.

A mutation on chromosome 18 results in some of the skeletal muscles becoming enlarged in sheep. The phenotypic expression of this mutation has been termed *callipyge*. We hypothesized that phenotypic differences in muscle weight begins during fetal development. Mature ewes were mated to rams that were homozygous for the mutation or did not have the mutation. Ewes with heterozygous twin fetuses (n = 19) and ewes with normal twin fetuses (n = 20) were serially slaughtered from 58 through 141 days of gestation and fetal and placental tissues were dissected and weighed. Fetal tissue weights on time were fit with a logistic function and placental tissues were fit with quadratic functions. Genotype-specific equations fit the weight data better than a pooled equation for the adductor, gastrocnemius, semitendinosus, semimembranosus, plantaris, and longissimus muscles ($P < 0.05$) and genotype-specific equations tended to fit better than a pooled equation for the gluteus medius ($P < 0.10$) and quadriceps ($P < 0.11$). Genotype-specific equations did not fit better for femur, tibia, and humerus length ($P > 0.23$); however, they did fit better for femur, tibia, and humerus weight ($P < 0.05$). Genotype-specific equations fit total fetal weight better than a pooled equation. Differences between the genotypes were the result of heavier tissue weights in the last trimester of *callipyge* fetuses. Caruncular weight and cotyledonary weight increased during mid gestation and decreased during late gestation. Caruncular weight of ewes with *callipyge* fetuses was lower than that of ewes with normal fetuses. Expression of the *callipyge* phenotype begins in utero. Deviation in muscle weight between genotypes begins to occur in the last trimester which coincides with the expected onset of muscle hypertrophy. These data suggest that mechanisms associated with expression of the *callipyge* phenotype occur during muscle hypertrophy.

Key Words: Fetal, Growth, Sheep

59 Interactions of a novel intermediate filament protein with two costameric proteins in muscle cells. N. Sun* and R. M. Robson, *Iowa State University, Ames.*

The novel intermediate filament (IF) protein synemin and the major IF protein desmin comprise the heteropolymeric intermediate filaments (IFs) that surround the myofibrillar Z-lines and link all adjacent myofibrils within striated muscle cells. In addition, the heteropolymeric IFs link Z-lines of the peripheral layer of cellular myofibrils to costameres located periodically along, and immediately subjacent to, the sarcolemma. In mammalian muscle cells, synemin is expressed as a larger A-synemin splice variant, and a smaller B splice variant. This differs from avian muscle cells that express only one isoform, an ortholog of mammalian A-synemin. Avian synemin has previously been shown in our lab to interact with vinculin. The detailed functions of the two synemin isoforms in mammalian muscle cells have remained unclear. The objective of this study was to determine whether one or both of the mammalian isoforms of synemin interacts with the costameric proteins vinculin and/or talin. Herein we report specific interactions of mammalian synemin with both vinculin and talin. Coimmunoprecipitation assays show an interaction of synemin with vinculin and talin in cultured rat smooth muscle cells (A-10 cells). Solid-phase protein-protein binding studies (blot overlays) and *in vitro* GST pull-down assays demonstrate that a specific region within mammalian A-synemin interacts with both vinculin and talin. In addition, colocalization of A-synemin with vinculin and talin in focal adhesion sites, which contain proteins also present in costameres, was revealed by immunofluorescent staining of cultured A-10 cells. These results suggest that, via direct interaction with vinculin and talin, the larger A-synemin isoform appears to function as a link between the heteropolymeric IFs and the costameres located subjacent to the sarcolemma. The heteropolymeric IFs appear to help provide mechanical integration of the cytoskeleton within mammalian muscle cells. (Supported by USDA-CSREES-NRICGP Award 2003-35206-12823)

Key Words: Myofibrils, Intermediate filaments

60 The effect of Optaflexx® dose and feeding duration on growth performance of steers. M. T. Van Koevinger*¹, A. L. Schroeder¹, G. J. Vogel¹, W. J. Platter¹, A. A. Aguilar¹, D. Mowrey¹, S. B. Laudert¹, G. E. Erickson², R. Pritchard³, M. Gaylean⁴, and L. Berger⁵, ¹Elanco Animal Health, Greenfield, IN, ²University of Nebraska, Lincoln, ³South Dakota State University, Brookings, ⁴Texas Tech University, Lubbock, ⁵University of Illinois, Urbana.

Four studies using 1,867 steers were conducted to evaluate the effects of Ractopamine HCL (RAC) on growth performance when fed for the final 28, 35 or 42 days (DUR) of the finishing period. At each study site, RAC was fed continuously to achieve intake doses of approximately 0 (CON), 100 (LOW) and 200 (HIGH) mg/hd/d. Each study consisted of four to nine replicates for each RAC by DUR combination with 5 to 11 steers/pen depending on study site. Analyses of growth performance data were conducted using a linear mixed model procedure, Proc Mixed, SAS v8.2, with pen as the experimental unit. The statistical model included RAC, DUR and RAC x DUR interaction as the independent

fixed effects, and study and block within study as random effects. There were no RAC x DUR interactions ($P > .62$). Feed intake for steers fed either level of RAC was not different compared to CON ($P > .07$). ADG was greater ($P < .0001$) for steers fed either dosage of RAC. Daily gain was increased by 6.9% and 10.7% for LOW and HIGH, respectively. Feed efficiency was improved ($P < .0001$) for both RAC dosages. Feed efficiency was improved 8.0% and 11.4% for steers in LOW and HIGH, respectively. These data demonstrate that RAC can maintain improved ADG and F:G throughout the 28 to 42 d approved feeding duration.

Table 1. The effects of ractopamine HCl on growth performance of feedlot steers

Item	RAC (mg/hd/d)			SEM
	0	100	200	
Pens, No.	79	79	79	
Animals, No.	624	624	619	
Daily Feed, kg	10.53	10.50	10.38	0.50
ADG, kg	1.44 ^a	1.54 ^b	1.60 ^b	0.14
Feed/Gain	7.60 ^a	6.99 ^b	6.73 ^b	0.44
48	26	13	24	10
	(66.67) ^{§c} §	(46.43) ^{§cd} §	(75.00) ^{§dA} §(34.48) ^{§bcB} §	

^{ab}Means differ ($P < .05$)

Key Words: Ractopamine, Steers, Growth

61 The effect of Optaflexx® dose and feeding duration on carcass traits of steers. M. T. Van Koevinger*¹, A. L. Schroeder¹, G. J. Vogel¹, W. J. Platter¹, A. A. Aguilar¹, D. Mowrey¹, S. B. Laudert¹, G. E. Erickson², R. Pritchard³, M. Gaylean⁴, and L. Berger⁵, ¹Elanco Animal Health, Greenfield, IN, ²University of Nebraska, Lincoln, ³South Dakota State University, Brookings, ⁴Texas Tech University, Lubbock, ⁵University of Illinois, Urbana.

Four studies using 1,867 steers were conducted to evaluate the effects of Ractopamine HCL (RAC) on carcass traits when fed for the final 28, 35 or 42 days (DUR) of the finishing period. At each study site, RAC was fed continuously to achieve intake doses of approximately 0 (CON), 100 (LOW) and 200 (HIGH) mg/hd/d. Each study consisted of four to nine replicates for each RAC by DUR combination with 5 to 11 steers/pen depending on study site. Analyses of carcass data were conducted using a linear mixed model procedure, Proc Mixed, SAS v8.2, with pen as the experimental unit. The statistical model included RAC, DUR and RAC x DUR interaction as the independent fixed effects, and study and block within study as random effects. Traits demonstrating a RAC x DUR interaction ($P < .07$) demonstrated the greatest treatment response with HIGH at 42 d. Carcass weights of steers fed RAC were heavier ($P < .0001$) than CON (2.8 kg LOW, 5.0 kg HIGH). RAC increased ($P < .001$) ribeye area and carcass conformation score for steers in LOW and HIGH. Calculated yield grade was decreased ($P < .002$) for steers in LOW and HIGH. Feeding RAC had no effect ($P < .21$) on marbling score. These data demonstrate that RAC maintains carcass weight throughout the 28 to 42 d approved feeding period while having greatest effects on carcass leanness at 42 d.

Table 1. Effects of ractopamine on carcass traits of feedlot steers

Item	RAC (mg/hd/d)			SEM
	0	100	200	
Hot Carcass Weight, kg	371.9 ^a	374.8 ^b	376.9 ^c	6.3
Dressing Percent, %	64.00	64.08	64.23	0.36
12 th Rib Fat Thickness, cm*	1.30	1.24	1.27	0.10
Ribeye Area, cm ² *	86.0 ^a	87.5 ^b	88.8 ^c	0.45
Yield Grade*	3.00 ^a	2.92 ^b	2.88 ^b	0.12
Marbling Score	529.7	531.1	523.1	11.1
Conformation Score*	20.8 ^a	20.9 ^b	21.0 ^b	0.30

^{abc}Means differ (P<.05); *RAC x DUR interaction (P<.07)

Key Words: Ractopamine, Steers, Carcass Traits

62 Unique interaction of intermediate filaments with A-actinin in skeletal muscle cells. S. E. Veneziano*, R. C. Bhosle, and R. M. Robson, *Iowa State University, Ames.*

Adjacent myofibrils within skeletal muscle cells are tied to each other at their Z-lines by long, 10 nm diameter intermediate filaments (IFs). The major IF protein is desmin, but much smaller amounts of a unique large IF protein, synemin, forms heteropolymeric IFs with desmin. Only one form of synemin is present in avian skeletal muscle cells. In mammalian

skeletal muscle cells at least two isoforms are expressed, A-synemin (avian synemin ortholog) and a smaller B-synemin with a shorter C-terminal tail domain. We have shown previously that avian synemin binds to A-actinin, a myofibrillar Z-line and costameric protein component. It has not been determined if the two mammalian synemin isoforms have different functions, nor whether either or both interact directly with A-actinin. Thus, our goals were to (1) determine if either, or both, synemin isoform(s) interact with A-actinin in mammalian skeletal muscle cells, (2) define the sites of interaction between the two proteins, and (3) compare the interactions within avian and mammalian skeletal muscle cells. Colocalization studies show that synemin organizes into a striated pattern and colocalizes with A-actinin in 8-day primary chick skeletal muscle cells and in mouse skeletal muscle (C2C12) cells differentiated for 5 days. Coimmunoprecipitation studies demonstrate an interaction between synemin and A-actinin in mouse skeletal muscle cells differentiated for 5 days and in primary chick skeletal muscle cells cultured for 2, 4 and 8 days. Solid-phase (blot overlay) protein binding studies indicate the C-terminal tail domain of mammalian A-synemin binds to both the head and rod domains of A-actinin-2, whereas the B-synemin tail domain does not. Our results indicate the overall interaction between synemin and A-actinin is similar in avian and mammalian skeletal muscle cells. Mammalian A-synemin, but not B-synemin, interacts with A-actinin and plays an important role in this cytoskeletal linkage. (Supported by USDA-CSREES-NRICGP Award 2003-35206-12823)

Key Words: Myofibrils, Intermediate filaments

Nonruminant Nutrition

63 Determination of bioequivalence ratio of D- α - to DL- α -tocopheryl acetate based on serum and liver α -tocopherol content of swine. H. Yang¹, D. Mahan², D. Hill³, T. Shipp³, and T. Radke¹, ¹ADM Animal Nutrition, Quincy, IL, ²The Ohio State University, Columbus, ³ADM Animal Health and Nutrition, Quincy, IL.

Two experiments (Exp1=29d, Exp2=32d) were conducted to determine bioequivalence ratio (BR) of d- α -tocopheryl acetate (D α T) to dl- α -tocopheryl acetate (DL α T). Gilts (n=24; BW=67 kg for Exp1 & 70 kg for Exp2) were individually housed. Exp1 & 2 contained five treatments (TRT) in a RCB design in four or five replicates. The TRTs of Exp1 were 1) DL α T addition at 22 mg/kg, 2) D α T addition at 16.18 mg/kg (BR1.36), 3) 11 mg/kg (BR2.00) and 4) 8.33 mg/kg (BR2.64), and 5) a non-vitamin E fortified negative control (NC). The first four TRTs of Exp2 were identical to Exp1, but TRT 5 was changed to D α T addition at 6.71 mg/kg (BR3.28). Prior to initiation of each Exp, pigs were fed a non-vitamin E fortified diet for 30 d. Corn-SBM diets were formulated to contain TID lysine 0.9% (depletion diet) and 0.8% (Exp diets). Day 0 serum α -tocopherol (α T) was a covariate for analysis of subsequent serum and liver α T. Polynomial analysis was conducted for DAT TRTs. As dietary D α T decreased, serum α T decreased linearly (P<.01) in the middle and end of both Exp1&2 as well as liver α T in Exp2. Serum or liver α T data from D α T TRTs were used to generate five regression equations to calculate BR. Serum data showed a BR of 2.01 (d15) and 1.85 (d29) in Exp1, and 2.83 (d15) and 2.89 (d32) in Exp2. The liver BR (d32) in Exp2 was 2.66. These results suggest an average biological equivalence ratio of 2.45, substantially above the accepted USP value of 1.36.

Table 1.

TRT	Exp1 & Exp2				Exp1 NC	Exp2 BR3.28	SE	P Value	
	DL α T	BR1.36	BR2.0	BR2.64				Lin	Quad
PPM	22.00	16.18	11.00	8.33	0.00	6.71			
Serum α T in Exp1 (Mg/ml)									
D 0	0.72	0.77	0.60	0.70	0.61		0.08	0.44	0.27
D 15	1.22	1.52	1.02	1.11	0.67		0.11	0.01	0.11
D 29	1.15	1.39	0.87	0.86	0.55		0.08	0.00	0.11
Serum α T in Exp2 (Mg/ml)									
D 0	0.71	1.16	1.11	1.01		1.11	0.12	0.55	0.73
D 15	1.27	1.96	1.57	1.35		1.16	0.09	0.00	0.58
D 32	1.35	2.03	1.62	1.46		1.24	0.10	0.00	0.66
Liver α T in Exp2 (Mg/g)									
D 32	2.96	4.39	3.33	2.75		2.75	0.23	0.00	0.38

Key Words: Vitamin E, Tocopherol, Pigs

64 Determination of the optimum dietary lysine concentration for pigs in the weight range 15 to 33 kg. M. K. O'Connell* and P. B. Lynch, *Pig Production Department, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland.*

The objective of this study was to determine the optimum dietary lysine concentration for pigs in the weight range 15 to 33 kg. Ninety-six

pairs of pigs (48 pairs entire male, 48 pairs female) were weaned at 28 days (8.0 ± 0.75 kg) and given commercial starter and link diets until assigned to treatment 19 days post weaning (15.3 ± 1.49 kg). Six treatments were arranged in a completely randomised block design. Isoenergetic cereal diets (14.0 MJ DE/kg; barley, wheat, soyabean, with added vitamins, minerals and amino acids) had increasing lysine concentrations (9.6, 10.7, 11.5, 12.4, 13.1 and 14.1 g/kg), and constant ratios of methionine plus cystine, threonine and tryptophan to lysine (0.60:0.69:0.21:1). Experimental diets were provided for 28 days, until pigs were 32.8 ± 3.33 kg. Performance results are presented in Table 1. A quadratic effect of increasing dietary lysine concentration was significant for both average daily gain (ADG; $P < 0.05$) and feed conversion ratio (FCR; $P < 0.05$), and the observed results suggested a plateau had been reached for both parameters. Two-slope broken line regression models were fitted to the data. The models indicated that above 12.6 g lysine/kg there was no further increase in ADG (659 g/d, R-square 0.94) or improvement in FCR (1.61 kg/kg, R-square 0.94). Entire male pigs grew faster than female pigs (ADG 627 v 603 g/d; $P = 0.05$) and they were more efficient (FCR 1.68 v 1.76 kg/kg; $P < 0.05$). It is concluded that for pigs in the weight range 15 to 33 kg, the optimum dietary lysine concentration is 12.6 g/kg.

Table 1. Effect of increasing dietary lysine concentration on ADG and FCR of pigs from 15 to 33 kg

	Dietary lysine concentration, g/kg						SEM	P-value ¹	
	9.6	10.7	11.5	12.4	13.1	14.1		Lin	Quad
Weight on, kg	15.2	15.8	15.1	15.6	15.3	15.2	0.37	ns	ns
ADG, g/d530	593	589	659	661	661	14.8		***	*
FCR, kg/kg	1.92	1.78	1.79	1.61	1.60	1.61	0.04	***	*
Weight off, kg	31.0	32.2	31.6	34.0	33.7	34.2	0.55	***	ns

¹Sex x treatment $P > 0.05$; Linear and quadratic significance, * $P < 0.05$, *** $P < 0.001$

Key Words: Pigs, Lysine

65 Evaluation of mineral retention and tissue mineral content in finishing pigs fed inorganic and organic trace minerals. A. Balfagon¹, M. D. Lindemann¹, K. J. Stalder², J. Burkett², J. Pierce³, and G. L. Cromwell¹, ¹University of Kentucky, Lexington, ²Iowa State University, Ames, ³Alltech Inc., Nicholasville, KY.

Commercial hybrid pigs were used to determine the effects of replacing supplemental inorganic Fe, Zn, Cu and Mn with graded levels of an organic source on mineral retention. Pigs were randomly allotted to four dietary treatments (1-inorganic [primarily sulfates], 2-organic [Alltech's Bioplexes], 3-reduced organic and 4-unsupplemented control) and fed four grow-finish phase diets until slaughter. During the final period, Trt 1 provided 20, 28, 16 and 5.2 mg/kg of supplemental inorganic Fe, Zn, Cu and Mn, respectively; Trt 2 provided 30, 30, 6.2 and 1.5 mg/kg of supplemental organic Fe, Zn, Cu and Mn, respectively; Trt 3 provided 1/2 the values of Trt 2; and Trt 4 contained no supplemental Fe, Zn, Cu

or Mn. At the end of the finishing period, 24 pigs (104.4 ± 5.2 kg BW) were fed individually for 5 d (after a 7d adaptation period) in metabolism crates to evaluate total mineral retention. Pigs were subsequently slaughtered (110.2 ± 4.7 kg BW) and heart, kidney, liver, a longissimus muscle sample, spleen and front feet obtained. The results of the metabolism study were equivocal with regard to the retention of Fe, Cu, and Mn; for Zn the retention was 36.0, 37.0, 28.8, and 13.8 mg/d for Trt 1-4, respectively, $P < 0.001$. Differences were observed in fecal excretion above that of unsupplemented pigs ($P < 0.05$; mg/d) of Fe (286, 243, 256, and 241) and Zn (69, 44, 53, and 45) for Trt 1-4, respectively. For total tissue mineral content, increased retention above that of unsupplemented pigs was observed for liver Fe (273, 259, 237, and 175 mg; $P < 0.05$), liver Zn (48, 64, 49, and 32 mg; $P < 0.001$), kidney Zn (2.1, 2.5, 2.1, and 1.8 mg; $P < 0.05$) and kidney Cu (0.22, 0.36, 0.26, and 0.19 mg; $P < 0.05$). Feeding of multiple minerals in a single study made exact comparisons difficult but there were indications that the organic Zn compound facilitated greater tissue deposition of Zn than the inorganic compound.

Key Words: Pig, Organic mineral, Retention

66 Effect of dietary trace minerals on pig growth and mineral excretion. T. S. Stahly*, T. R. Lutz, and R. D. Clayton, Iowa State University, Ames.

Pigs (7 kg initial BW) were fed a basal diet supplemented with one of four incremental additions of a mixture of trace minerals (Cu, Fe, Mn, Zn as sulfates and I as K iodate) for four weeks. The basal diet consisted of a corn, SBM, whey protein concentrate, casein, soy oil mix supplemented with phytase, mono-dical phosphate, reagent grade Ca carbonate and vitamins and was formulated to provide 100 % of the NRC (1998) estimated needs of the trace minerals (TM). The incremental additions provided an additional 0,100, 200 or 300% of the estimated TM needs. Within each of 28 litters, four littermates were individually penned and randomly allotted to one of the four dietary groups. Feed intake, body growth and mineral (analyzed by ICP, I not analyzed) intakes-excretions were determined weekly. No week x diet interaction occurred, thus data pooled across weeks are reported. Dietary TM additions did not alter daily body gain (567, 587, 575, 582 g) or gain/feed ratios (722, 744, 727, 731 g/kg). The amounts of Cu, Fe, Mn, and Zn ingested, retained and excreted daily increased ($P < 0.05$) as dietary TM additions increased. The proportion of these minerals ingested that were retained/excreted were independent of dietary TM concentration except for Fe at the highest addition. The TM content of the excreta, expressed as a percentage of the total excreta or as mg per g of excreted phosphorus (P), was increased ($P < 0.05$) linearly as dietary trace mineral additions increased. Specifically, the ratios of Cu, Fe, Mn and Zn to P in the excreta increased from 1.4 to 5.6, 86 to 142, 5.4 to 9.1, and 34 to 113 mg/g P, respectively, as supplemental TM additions increased from 0 to 300 % NRC. Based on these data, TM concentrations in a phytase supplemented diet equivalent to the NRC (1998) estimated needs support maximum rate and efficiency of growth in high lean pigs but the TM contents of the pig's body and excreta are dependent on the animal's dietary TM regimen. Acknowledgement of contributions to the study of J.A. Zahn, USDA, ARS, NSRIC and D.A. Laird, USDA, ARS, NSTL.

Key Words: Trace minerals, Phosphorus, Pig

67 Effect of feeding reduced phosphorus diets on bone characteristics of swine reared under both research and commercial settings. R. Hinson*, A. Schinckel, A. Sutton, and B. Richert, *Purdue University, West Lafayette, IN.*

Three experiments in research settings (Exp. 1, 98 hd; Exp. 2, 148 hd; Exp. 3, 384 hd) and two experiments in commercial settings (Exp. 4 and 5, 256 hd each) were conducted to determine the effects of feeding low nutrient excretion (LNE) diets formulated with reduced crude protein, amino acid supplementation, and phytase (Exp. 4 and 5), plus, low phytic acid corn (Exp. 1 and 2) with 7% soybean hulls and a non-sulfur trace mineral premix (Exp. 3) on pig performance and bone characteristics. Overall growth performance was similar ($P > .10$) between treatments in Exp. 1, 2, and 5 and was reduced ($P < .05$) in Exp. 3 and 4 when feeding LNE type diets. Carcass characteristics were similar ($P > .05$) between treatments in all experiments. Subsets of pigs were harvested at the end of the nursery (Exp. 2, 24 hd, 25.2 kg BW), grower (Exp. 2, 40 hd, 71.7 kg BW), and finisher phases (Exp. 1, 40 hd, 125.9 kg BW; Exp. 2, 40 hd, 125.0 kg BW; Exp. 3, 94 hd, 88.1 kg BW; Exp. 4, 40 hd, 115.3 kg BW; Exp. 5, 40 hd, 117.6 kg BW). Front feet (Exp. 3) or both feet from the left side of the carcass (Exp. 1, 2, 4, and 5) were removed after harvest and the metacarpal and metatarsal bones were removed to determine % ash and peak breaking strength. At the nursery phase (Exp. 2), dry fat-free extracted weight was reduced ($P < .05$) with the feeding of the LNE diets. At the grower phase (Exp. 2), metacarpal and metatarsal ash weight, ash %, and peak breaking strength were reduced ($P < .05$) with the feeding of the LNE diets. At the end of the finisher phase LNE diets reduced ($P < .05$) metatarsal ash % (Exp. 1, 2, and 4), metatarsal ash mass (Exp. 4 and 5), metatarsal breaking strength (Exp. 4; 78.7 vs 105.7 kg) and metacarpal dry fat-free weight (Exp. 2 and 3), metacarpal ash mass (Exp. 2, 3, and 4) metacarpal peak breaking strength (Exp. 3, 64.4 vs 91.5 kg; Exp. 4, 97.0 vs 120.8 kg) compared to the control type diets. Feeding reduced P diets negatively impacted bone characteristics of pigs reared under both research and commercial settings.

Key Words: Swine, Reduced phosphorus diets, Bone characteristics

68 Ingestion of endophyte infested fescue does not affect exercise recovery of horses exercised at a light workload. G. Webb*, S. Webb, and R. Humes, *Missouri State University, Springfield.*

During the summer months, 12 horses averaging 533 kg were fed either orchard grass (*Dactylis glomerata*) or endophyte infested tall fescue (*Festuca arundinacea*) hay which averaged 1995 ppm ergot alkaloids. Horses were maintained on free choice orchard grass hay only diets 14 d prior to and between two experimental periods. During the 14 d experimental periods, six horses were offered orchard grass control and six were offered fescue hay on a free choice basis. During the last 4 d of each 14 d period horses were individually housed in 13.3 m² stalls so that individual intake and refusals could be recorded. During period 2, horses were fed the opposite hay from period 1. Fescue hay averaged 10.7% CP and 50.7% TDN compared to 14.9% CP and 55.3% TDN for orchard grass. In order to establish a light workload, horses were exercised 30-45 min/d, 4 d per wk in all periods. On day 14 of each test period horses were subjected to an exercise tolerance test consisting of 4 min at a walk, 14 min at a trot and 6 min at a lope/gallop with target heart rate ranges of 50-70, 71-110 and 111-150 beats per minute respectively. Weight of rider and tack as a percent of horse BW was standardized. All tests were done in an indoor arena between 1200 and 1430 h.

Ergot alkaloids in urine samples from horses consuming fescue averaged 282.2 ng/mg creatine compared to 14.4 ng/mg creatine for those consuming orchard grass. Horses consumed more ($P < .01$) orchard grass than fescue (2.06% vs. 1.69 % B.W/day) and lost less ($P < .01$) weight (4.3 vs. 29.3 kg) during the 14 d experimental periods. No difference was observed ($P < .01$) for pre or post exercise rectal temperatures or respiration rates after 1, 5 and 10 min of recovery between treatment groups. Ingestion of fescue with high levels of ergot alkaloids did not affect post exercise recovery of temperature, heart rate or respiration when horses were subjected to a light workload.

Key Words: Fescue, Equine, Exercise

69 Oregano essential oils (OEO) supplementation and its effect on reproductive performance of sows, growth pattern of piglets and their immune measurements. C. Ariza-Nieto*, S. K. Baidoo, M. Bandrick, and T. W. Molitor, *University of Minnesota, St. Paul.*

A study was performed to evaluate supplementation of OEO in gestation and lactation sow diets on sow reproductive and suckling pig performance. Within 24 hours after service, 150 sows were randomly assigned to one of two groups: control and oregano (OEO 250ppm of Regano500®). Blood was collected via jugular from 6 randomly chosen sows per treatment and their litter at farrowing (piglets bled before and after suckling), 7, and 14 days of lactation. Colostrum and milk samples were collected on these days. T lymphocytes subpopulations ($\Gamma\Delta$, CD8, CD4) were enumerated from whole blood. Natural cytotoxicity was used to assess functional activity associated with innate immunity in pigs. To evaluate growth rates due to OEO supplementation, 686 piglets were individually identified and weighed at 1, 5, 9, 12, 16, and 19 days of age. The number of live born piglets was higher when sows were supplemented with OEO during gestation (+1.1 piglets, $P < .05$). Sows fed OEO during gestation-lactation improved litter weaning weight and litter weight gain (2.7 and 3.3 kg; $P < .05$) compared to control. Breeding value sow productivity (BVSP) and sow productivity index (SPI) were higher ($P < .01$) in OEO fed sows (104 v 99 and 115 v 98, respectively). Wean to service interval was lower in OEO fed sows compared to control (5 v 8 days). Growth rate of piglets was higher ($P < .01$) in sows fed OEO on 1-5, 9-12, and 16-19 days of lactation. Piglets from sows fed OEO during gestation-lactation showed the greatest ($P < .05$) amount of IGF-1 at day 14 of lactation (135 ng/ml). The percentage of $\Gamma\Delta$ lymphocytes isolated from piglets before suckling from sows fed OEO was greater ($P < .05$) than control, although no differences were observed after suckling. These pigs also demonstrated greater natural killer (NK) activity throughout lactation, and significantly greater NK activity before suckling ($P < .01$). OEO supplementation during gestation and lactation shows a biological growth potential on suckling piglets.

Key Words: Oregano, Growth, Immune response

70 Effects of increasing oregano oil in nursery pig diets. C. R. Neill*, J. L. Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. M. DeRouchey, *Kansas State University, Manhattan.*

A total of 210 weanling pigs (PIC L327 \times L42) with an initial weight of 5.4 kg and 21 d of age were used in a 28-d growth trial to evaluate the

effects of increasing oregano oil on growth performance of weanling pigs. Oregano oil is an extract derived from the Greek oregano herb, *Origanum vulgare*. The oregano oil (5%) is mixed with an inert carrier (95%) to make a premix that is added to the diet. There were seven pigs per pen and six pens per treatment. Pens consisted of four barrows and three gilts or three barrows and four gilts. Pigs were blocked by weight and randomly allotted to one of five dietary treatments. Dietary treatments were: a negative control diet (without an antibiotic or oregano oil); a positive control diet containing neomycin/oxytetracycline (NT; 154 ppm); and the negative control diet plus oregano oil premix at 0.05, 0.10, or 0.20% of the diet. Oregano oil concentration remained constant for the 28-d trial. From d 0 to 14, ADG, ADFI, and G:F improved ($P < 0.01$) for pigs fed NT compared with those fed oregano oil or the control diet. From d 0 to 28, ADG and ADFI increased ($P < 0.006$) in pigs fed NT whereas G:F was not improved ($P = 0.35$) compared with pigs fed the negative control diet (see table). Pigs fed oregano oil had similar ($P > 0.15$) ADG, ADFI, and G:F compared with pigs fed the negative control diet. Pigs fed NT had increased ($P < 0.04$) ADG, ADFI, and G:F compared with pigs fed any level of oregano oil. In conclusion, NT improved growth performance of weanling pigs; whereas, oregano oil did not influence pig performance.

Table 1. Effects of increasing oregano oil in nursery pig diets

D 0 to 28	Negative Control	Positive Control	Oregano oil, %			SE
			0.05	0.10	0.20	
ADG, g	357 ^b	418 ^a	356 ^b	354 ^b	358 ^b	17.289
ADFI, g	450 ^b	520 ^a	455 ^b	459 ^b	461 ^b	23.138
G:F	0.79 ^{ab}	0.81 ^a	0.78 ^{ab}	0.77 ^b	0.78 ^b	0.013

^{ab} Means in the same row without common superscript differ ($P < 0.05$).

Key Words: Antimicrobial, Nursery pigs, Oregano

71 Effect of whey protein concentrate source on growth performance of nursery pigs. R. O. Gottlob*, J. M. DeRouche, M. D. Tokach, R. D. Goodband, S. S. Dritz, J. L. Nelssen, C. R. Neill, and C. W. Hastad, *Kansas State University, Manhattan*.

A total of 228 weanling pigs (6.8 kg and 21 d of age) were used to evaluate the effects of whey protein concentrate (WPC) source on growth performance. Pigs were blocked by BW and sex and allotted to one of seven diets in an unbalanced complete block design. There were five or six pigs per pen (equalized within block) with five pens for each control and six pens for each WPC treatment. The seven treatments included a negative control with no WPC, a positive control with 5% spray-dried animal plasma (SDAP), or the negative control diet with WPC from one of five sources. Sources of WPC varied in CP from 57.6 to 80.2% and replaced SDAP on a lysine basis. Pigs were fed experimental diets from d 0 to 14 and a common diet from d 14 to 28. For d 0 to 14, ADG was 206, 242, 248, 225, 206, 237, and 235 g/d and G:F was 0.71, 0.79, 0.84, 0.80, 0.80, 0.83, and 0.84 for pigs fed the negative and positive control and WPC sources 1 to 5, respectively. Pigs fed WPC had improved ($P < 0.01$) G:F compared to pigs fed the control diet, but tended to have

decreased ($P < 0.09$) ADFI compared to pigs fed diets containing SDAP. Pigs fed diets containing Source 1 WPC had greater ADG ($P < 0.05$) than pigs fed the control diet or diets containing Source 3 WPC, while pigs fed other diets were intermediate. Pigs fed diets containing SDAP had greater ADFI ($P < 0.05$) than pigs fed diets containing Source 3 WPC, while pigs fed other diets were intermediate. Pigs fed diets containing Source 1, 4, or 5 WPC had improved G:F ($P < 0.05$) compared to pigs fed the control diet. From d 0 to 28, pigs fed diets containing Source 1 WPC had greater ADG ($P < 0.05$) than pigs fed diets containing Source 3 WPC. There were no differences in overall ADFI and G:F and no differences in overall performance between pigs fed WPC and SDAP. The difference in growth performance of pigs fed WPC confirms our previous results in that variation between WPC sources exists. Pigs fed diets containing high quality WPC can have similar performance to those fed SDAP.

Key Words: Nursery pigs, Plasma, Whey protein concentrate

72 Evaluation of regional differences in nutrient composition and physical characteristics among six U.S. soybean meal sources.

P. E. Urriola*¹, M. H. Whitney², N. S. Muley¹, and G. S. Shurson¹, ¹*University of Minnesota, St Paul*, ²*Extension Regional Center, Mankato, MN*.

A total of 86 soybean meal (SBM) samples were collected monthly from July 2003 to December 2004 from 6 soybean processing plants (SPP) located in two regions (R): North Carolina (n = 13), South Carolina (n = 13), and Alabama (n = 12) in the southern region (SR), and two Minnesota (n = 14, respectively) and one South Dakota SPP (n = 20) in the northern region (NR). Subsamples were sent to Iowa Testing Laboratory (Eagle Grove, IA) for proximate and mineral analysis, and to the University of Missouri for amino acid analysis. Additional subsamples were analyzed for bulk density and particle size. All nutrient values were expressed on a DM (%) basis. Crude protein (55.23 ± 0.14) and ash (7.02 ± 0.05) content were influenced ($P = 0.004$) by year, R, and SPP. However, crude fat (1.68 ± 0.05) was affected only by SPP ($P = 0.0001$), while crude fiber (3.77 ± 0.03) was affected only by year ($P = 0.01$). Samples from SR were higher ($P = 0.05$) in lys (3.45 ± 0.02), met (0.77 ± 0.01), thr (2.08 ± 0.01), and trp (0.76 ± 0.01) than NR (3.38 ± 0.01 , 0.74 ± 0.01 , 2.00 ± 0.01 , and 0.73 ± 0.01 , respectively). Crude protein of SBM was poorly correlated with essential amino acid content ($r^2 = 0.52$). Total amino acid content and total non-essential amino acids were higher ($P = 0.001$) for SR compared to NR. Concentrations of P, K and Mn were higher ($P = 0.001$) in samples from SR than NR. However, Ca, Mg, Na, S and Zn content was similar ($P = 0.035$) between R. Average particle size (μm) was higher ($P = 0.001$) in NR (851 ± 33) compared to SR (731 ± 31). Bulk density (kg/m^3) was similar ($P = 0.41$) between R (532 ± 3). Mean particle size and bulk density values were different ($P = 0.002$) between SPP. Although there were significant differences in nutrient content and physical characteristics of soybean meal samples among regions, year, and SPP, these differences were small and of minimal consequence when formulating practical animal diets.

Key Words: Soybean meal, Nutrient composition, Physical characteristics

73 Effect of feed intake level, body weight and pig genotype on the distribution of dissectible lean and fat tissue in finishing gilts. H. R. Martínez-Ramírez*, T. D. Woods, and C. F. M. de Lange, *University of Guelph, Guelph, Ontario, Canada.*

The value of pig carcasses is determined by both the content and the distribution of dissectible lean (**Lean**) and fat tissue (**Fat**). A total of 28 gilts (27.1 ± 1.5 kg BW) were used in a 2x2x2 factorial design to evaluate the effect of two feed intake levels (**FL**, 70 vs 90% of ad libitum intake according to NRC, 1998), two pig genotypes (**PG**; **S** vs **A**) and two slaughter **BW** (100 vs 125 kg BW) on the distribution of Lean and Fat contents in the carcass. Throughout the experiment pigs were fed diets that exceed requirements for essential nutrients. There were no interactive effects of FL, PG and BW on growth performance and Lean and Fat contents in the carcass ($P > 0.10$). Based on regression analysis, pigs on FL 90% grew faster than pigs on 70% (956 vs 812 g/d; $P < 0.001$). Similarly, S pigs grew faster and had higher Lean content than A pigs (903 vs 866 g/d, 54.5 vs 52.2%; $P < 0.05$). However, there were interac-

tive effects of FL and BW on the distribution of Lean over the main carcass cuts (belly, ham, loin and shoulder; $P < 0.005$). At 100 kg BW the contribution of loin to total Lean was increased with increasing FL (70% = 24.4% vs 90% = 25.2%), while it was reduced with increasing FL at 125 kg BW (70% = 24.7 vs 90% = 22.9%). Carcass Fat content was affected by BW (100 kg = 11.5% vs 125 kg = 13.2%; $P < 0.05$), PG (S = 11.6% vs A = 13.1%; $P < 0.05$) and FL (70% = 11.5% vs 90% = 13.2%; $P < 0.05$). However, the contribution of ham to total Fat content was inversely related to FL (70% = 29.3% vs 90% = 25.9%; $P < 0.05$). The contribution of leaf lard to total Fat content increased with FL (70% = 9.4% vs 90% = 11.4%; $P < 0.01$) and decreased with BW (100 kg = 11.1% vs 125 kg = 9.71%; $P < 0.05$). The contribution of external Fat to total Fat was affected by FL (70% = 76.8 vs 90% = 80.3%; $P < 0.01$). These results indicate that total Lean and Fat content in the carcass were influenced by PG and FL and that the distribution of Lean and Fat in the carcass was affected by FL and slaughter BW.

Key Words: Pigs, Feeding intake, Body composition

Odor and Nutrient Management

74 Effects of feeding varying concentrations of dry distillers grains with solubles to finishing steers on the nutrient concentration of manure scrapings and soil core samples from an earthen floor feedlot. C. Benson, K. Tjardes, and C. Wright*, *South Dakota State University, Brookings.*

A study was conducted to determine the effects of feeding varying concentrations of dry distillers grains with solubles (DDGS) to finishing steers on the nutrient concentration of manure scrapings and soil core samples from an earthen floor feedlot. Steers ($n = 192$; initial BW = 385.9 ± 8.2 kg) were blocked by receiving date, weighed, and randomly allotted to 16 earthen floor pens (14.7 m \times 34.7 m; 5% slope). Pens were then randomly assigned to one of four dietary treatments. The control diet (CON) contained 82% cracked corn, 10% alfalfa hay, 4% molasses, 3.2% supplement, and 0.8% urea on a dry matter basis. In the remaining three treatment diets, all of the urea and portions of the cracked corn were removed and replaced with DDGS at 15% (15% DDGS), 25% (25% DDGS), and 35% (35% DDGS) of the diet DM. Diets were formulated to be isocaloric and to provide similar levels of CP for CON and 15% DDGS (13.2 and 13.3% CP, respectively) and a stepwise increase in CP for 25% and 35% DDGS (15.4 and 17.6%, respectively). Pen floor core samples (7 per pen; 0 to 15.24 cm depth) were taken prior to animal introduction and upon completion of the trial, after surface manure was removed with a box scraper. Organic matter, $\text{NO}_3\text{-N}$, Kjeldahl-N, and K concentrations of soil core samples were not affected by treatment. Differences in Olsen-P and $\text{NH}_4\text{-N}$ concentrations from the initial to the final sampling period tended ($P < 0.15$) to be greater for the 35% DDGS treatment than for all remaining treatments. Increasing levels of DDGS linearly increased ($P < 0.01$) Olsen-P and $\text{NH}_4\text{-N}$ in manure scrapings on a DM basis. Dry matter and Kjeldahl-N concentrations in manure scrapings were not affected by treatment. Increasing the level of DDGS in the diet increases Olsen-P and $\text{NH}_4\text{-N}$ in manure and may increase Olsen-P and $\text{NH}_4\text{-N}$ in pen floor core samples.

Key Words: Distillers grains, Feedlot, Nutrient management

75 Effect of feeding a reduced crude protein and phosphorus diet on compartmental and whole body mineral masses of pigs reared under commercial settings. R. Hinson*¹, A. Sutton¹, A. Schinckel¹, B. Richert¹, G. Hill², and J. Link², ¹*Purdue University, West Lafayette, IN*, ²*Michigan State University, East Lansing.*

Two experiments were conducted, each utilizing 256 pigs that were randomly selected within four 1,000 hd wean-finish buildings (32 barrows (B) and 32 gilts (G)/barn), to determine the effects of feeding a control corn-SBM based diet (CTL) or a low nutrient excretion diet (LNE), with synthetic amino acids and phytase, on grow-finish pig growth, carcass characteristics, and whole body mineral masses. Two barns were assigned CTL diets and two were assigned LNE diets during each experiment. Six (Exp. 1) and four (Exp. 2) phases of each diet were fed. The LNE diets were balanced on ideal amino acid ratios with reduced P levels. At the end of each experiment (Exp. 1, 114.8 kg BW; Exp. 2, 115.5 kg BW), 10 pigs/sex/barn were harvested to determine carcass characteristics and mineral masses of the blood, visceral organs, and carcass. Overall growth performance was reduced ($P < .05$) in Exp. 1 and maintained ($P > .10$) in Exp. 2 when feeding the LNE diets. Carcass characteristics were similar ($P > .05$) in both experiments between the diets. In Exp. 1 there was a trt \times sex interaction ($P < .04$) for Ca mass. When the CTL diets were fed, Ca mass was 1.01 and 1.06 kg in the B and G, respectively. However, when the LNE diets were fed, Ca mass was 1.09 and 0.97 kg in the B and G, respectively. In Exp. 1, empty body lipid mass was greater ($P < .01$) in the LNE pigs than the CTL fed pigs (49.6 vs. 46.4 kg). In Exp. 2, when the CTL diets were fed, lipid mass was 42.3 and 39.3 kg in the B and G, respectively. However, when the LNE diets were fed, lipid mass was 52.9 and 45.2 kg in the B and G, respectively (trt \times sex interaction; $P < .001$). Nitrogen (2.47 vs. 2.55 kg), Mg (27.8 vs. 28.9 g), and Cu (89.8 vs. 96.7 mg) mass were reduced ($P < .05$) and P mass tended to be reduced (487.6 vs. 508.0 g; $P < .06$) with the feeding of the LNE diets in Exp. 2. The feeding of these LNE diets increased lipid mass (Exp. 1 and 2) and decreased P, N, Mg, and Cu mass (Exp. 2). Low nutrient excretion diets affected whole body mass in grow-finish pigs but did not affect carcass quality.

Key Words: Pigs, Diet manipulation, Empty body mineral masses

Physiology

76 Using ultrasound as a quantitative tool to assess body condition score in Quarter and Thoroughbred horses. B. McCoy¹, N. Wheeler*¹, J. Willard¹, T. Wistuba¹, P. Prater¹, and B. Sandelin², ¹Morehead State University, Morehead, KY, ²California State Polytechnic University, Pomona.

Horse production in Kentucky is the largest agricultural system in the state based on income from farm products. Horse operations are currently the most important source of agricultural income for producers, due to the continued decline in tobacco production. Twenty mature horses (11 Quarter horses (QH) and 9 Thoroughbreds (TB)) were simultaneously subjected to objective body condition scoring and real-time ultrasound. Overly conditioned horses can result in reproductive problems, increased maintenance costs, as well as, generalized health and management issues. Measures of subcutaneous fat deposition were taken at the center of the crest of the neck, the center of the neck, center of 10th rib, center of rump between the point of the hip and point of the buttocks, and over the tail head in accordance with evaluating BCS in horses as reported by Henneke et al. (1983). Subcutaneous fat measurements were taken by a CUP certified ultrasound technician with an ALOKA 500V ultrasound unit equipped with a 5.0 MHz linear transducer. Ultrasound images were immediately interpreted by the technician for the determination of subcutaneous fat. Data were analyzed with method of least squares analysis of variance and correlation coefficients were calculated using PROC CORR procedure of SAS. When both breeds were included in the model, all subcutaneous fat measurements were correlated to BCS. The center of the rump measurement and the center of the neck regions were the most highly correlated at 0.58 and 0.54 respectively. When breeds were compared QH tended ($P < 0.17$) to have higher levels of subcutaneous fat in the regions of the center of the neck, the center of the rump, and the crest. Furthermore, this resulted in QH having a greater BCS when compared to TB ($P < 0.01$). There were no differences in subcutaneous fat levels detected between QH and TB at the center of 10th rib or over the tail head. This data suggests that ultrasound measurement may be a means of quantitatively analyzing body condition score in horses.

Key Words: Ultrasound, Horse, Body condition score

77 Fatty acid composition of the pig conceptus and endometrium in response to maternal omega-3 fatty acid supplementation. A. E. Brazle*¹, B. J. Johnson¹, E. C. Titgemeyer¹, S. K. Webel², and D. L. Davis¹, ¹Kansas State University, Manhattan, ²JBS United, Inc., Sheridan, IN.

Fatty acid composition of pig fetuses is affected by maternal diet, however effects on the composition of the gravid uterus in early pregnancy have not been evaluated. Here we report effects of supplementing a corn-soybean meal diet (Control) with a marine source of protected omega-3 fatty acids (PFA, 1.5% of diet). The PFA (Fertilium[®]) contained equal amounts of eicosapentaenoic (EPA), and docosahexanoic (DHA) acids and replaced corn in the diet. When gilts were approximately 170 d old, a blood sample was collected and dietary treatments initiated. A second blood sample was collected after 30 d of treatment and gilts ($n=13$ /treatment) were artificially inseminated at approximately 205 d of age. At d 11, 15, or 19 of gestation, conceptus and endometrial

samples were collected. All gilts were pregnant. Plasma samples revealed that PFA increased ($P < 0.005$) circulating EPA and DHA. In the endometrium, PFA increased ($P < 0.05$) concentrations of linoleic (13%) and linolenic acid (21%). Docosapentaenoic (DPA), DHA, and EPA were greater ($P < 0.05$) for PFA than controls on all days and were affected by d x treatment interactions ($P < 0.05$). Both DPA and DHA decreased ($P < 0.0005$) from d 11 to 19 but the percentage decrease was greater for PFA gilts. Endometrial EPA increased ($P < 0.0001$) from d 11 to 19 and the increase was greater for PFA gilts. In extraembryonic tissues (d 15 and 19) PFA more than doubled ($P < 0.0001$) EPA and DHA concentrations. Extraembryonic content of these fatty acids decreased ($P < 0.0001$) during this interval and the decline was greater ($P < 0.002$) in PFA gilts. In embryonic tissue on d 19, DHA was increased ($P < 0.05$) 47% by PFA. Therefore supplementing PFA from 30 d before breeding, affected conceptus and endometrial composition on d 11 to 19 of pregnancy. Because dynamic day effects in fatty acid composition were also observed, this may be a critical period for maternal fatty acid resources to affect conceptus development and survival.

Key Words: Pig, Conceptus, Omega-3 fatty acids

78 Effect of feed restriction and hypothermia on fetal development of mice. E. Maricle* and W. Lamberson, University of Missouri, Columbia.

Low birth weights in highly prolific pigs can result in increased preweaning mortality. Anecdotal evidence in sheep and cattle suggests restricting feed early in gestation and/or cooling late in gestation increase birth weights. Therefore, the objective of this study was to determine the effect of early gestational feed restriction in combination with late gestational chilling on term decidua and fetal weights, and prenatal survival in mice. The study used 37 ICR male mice, each mated 8 d with 4 females except for one male with 5 females. Once a female had a vaginal plug, she was individually caged. Pregnant females were allocated to one of four groups: full feed-normal temperature (22° C), full feed-chilled temperature (18° C), restricted feed-normal temperature, and restricted feed-chilled temperature ($n = 18, 19, 23$ and 16 , respectively). The restricted feed females were fed 80% of their previous five day's intake from d 5 to 10 of gestation while full feed females were fed ad libitum (Labdiet 5001, PMI International, Brentwood, MO). All females were fed ad libitum from day 10 to 18. On d 14 the chilled temperature females were moved to an 18°C environmental chamber while the normal temperature females were moved to an environmental chamber at 22°C. On d 18 the females were sacrificed and fetal weight, respective fetus's decidual weight, and number of corpora lutea and implantations were recorded. During restriction, intake of restricted mice was 68% of full feed mice. Immediately after restriction, there was a compensatory increase in intake by restricted mice. During the full length of gestation, restricted mice consumed 93.8% that of full feed mice. There were no significant differences in pre- or postimplantation survival rates among the four groups. There was also no significant difference between chilled temperature and normal temperature for decidual or fetal weights. However, full feed mice had greater ($P < 0.05$) birth weights than restricted feed mice (1.36 vs. 1.31 g). Feed restriction and hypothermia during gestation did not increase fetal growth in mice.

Key Words: Feed restriction, Fetal growth, Hypothermia

Ruminant Nutrition

79 Effect of imprinting lambs to corn supplementation pre-weaning on post-weaning grazing performance. G. Lowe*, S. Loerch, D. Clevenger, and P. Tirabasso, *The Ohio State University, Wooster*.

Lambs grazing pasture typically have slow growth rates. Providing supplement to grazing lambs is problematic due to low and inconsistent supplement intake. The objective of this experiment was to determine the effect of a pre-weaning learned behavior (supplementing corn to ewes and their lambs while grazing) on supplement intake and lamb grazing performance post-weaning. Twenty four Hampshire × Dorset ewes (avg BW = 87 kg) rearing twin lambs were allotted to six 0.6 ha orchardgrass pastures. Three treatments were investigated with two pasture replicates per treatment. Treatments were: 1) Control (no corn supplementation pre- or post-weaning); 2) Not Imprinted (supplementation with whole shelled corn only during the post-weaning period); 3) Imprinted (corn provided to ewes and lambs 7-d pre-weaning and post-weaning while grazing pastures. Lambs averaged 68 d of age at weaning and the post-weaning grazing trial was 49 d. From d 0-7, 0-14, and 0-49, DMI of supplemented corn was 0.04, 0.16, and 0.27 kg/d, respectively, for Not Imprinted lambs. Corn intake was greater ($P < 0.06$) for Imprinted lambs during these periods (0.21, 0.28, and 0.44 kg/d, respectively). However, increased corn intake did not affect ($P > 0.45$) ADG. Gains from d 0 to 49 were 86, 136 and 125 g/d for Control, Not Imprinted, and Imprinted treatments, respectively. Intake of supplement within group may have varied as lambs adjusted to corn in their diet. In the first 11 d, two lambs in each supplemented replicate died (one due to acidosis and one due to coccidiosis). Imprinting and corn supplementation did not affect ($P > 0.30$) percentage of lambs requiring anthelmintics (96% across experimental treatments) or the number of anthelmintic treatments per lamb (average across experimental treatments was 1.27). Treatment for internal parasites was based on FAMACHA eye score. While imprinting a novel feed source increased supplement intake, performance of grazing lambs was not improved.

Key Words: Lambs, Grazing, Supplement

80 Effects of corn supplementation on internal parasite infection of grazing lambs. P. Tirabasso*, S. Loerch, D. Clevenger, and G. Lowe, *The Ohio State University, Wooster*.

The objective of this experiment was to determine the effect of corn supplementation on internal parasite infection of grazing lambs. Twenty four Hampshire × Dorset ewes (avg BW = 87 kg) rearing twin lambs were allotted to six 0.6 ha orchardgrass pastures. Three treatments were investigated with two pasture replicates per treatment. Treatments were: 1) Control (no corn supplementation pre- or post-weaning); 2) Not Imprinted (supplementation with whole shelled corn only during the post-weaning period); 3) Imprinted (corn provided to ewes and lambs 7 d pre-weaning and post-weaning while grazing pastures. Lambs averaged 68 d of age at weaning and the post-weaning grazing trail was 49 d. Lambs were evaluated weekly for clinical anemia using the FAMACHA eye color scoring system (1-5 where 1 is not anemic and 5 is severely anemic). Cydectin (Fort Dodge Animal Health, Fort Dodge, IA) was the anthelmintic used to treat anemic lambs. Hematocrit and fecal egg counts were determined on d-21, 35 and 49. During the 49 d trial, Imprinted

lambs consumed more ($P < 0.06$) corn supplement than Not Imprinted lambs (0.44 vs 0.26 kg/d). Supplementation strategy did not affect ($P > 0.30$) the percentage of lambs requiring anthelmintic treatment (96%), or the average grazing days until first treatment (avg = 19 d). On d-21, 35 and 49, FAMACHA scores, hematocrits and fecal egg counts were variable and not affected ($P > 0.20$) by supplementation strategy. On d-21, for lambs not previously treated with anthelmintic, Control lambs had an average FAMACHA score of 2.2, hematocrit of 27.1% and 7370 eggs/g of feces. These values (respectively) were 2.1, 29.7%, and 4607 for Not Imprinted lambs and 2.0, 31.5%, and 3276 for Imprinted lambs. Only the difference in hematocrit between Control and Imprinted was significant ($P < 0.07$). The relationship between FAMACHA score and hematocrit was poor ($r^2 = .09$). Corn supplementation strategy did not improve the ability of grazing lambs to resist internal parasite infection.

Key Words: Lamb, Grazing, Parasites

81 Integration of cool- and warm-season grass pasturing systems into cattle finishing programs. R. A. Edler*^{1,2}, M. P. Hoffman¹, and P. Tseng¹, ¹Iowa State University, Ames, ²Boehringer Ingelheim Vetmedica, Ames, IA.

A four-year study, using 116 fall-born calves per year, was conducted to evaluate the integration of intensive stocking of both cool- and warm-season grass pastures with drylot finishing. Four treatments were assigned on May 1st of each year respectively: 1) calves directly into the feedlot (DF); 2) calves stocking bromegrass pasture until early July and then moved to feedlot (JC); 3) calves stocking bromegrass pasture until mid-June at which time they were moved to warm-season pastures, until returned to the cool-season pasture from mid-August to October when they were placed into the feedlot (OW); 4) calves stocking bromegrass pasture until October and then moved to feedlot (OC). Each treatment consisted of 28 calves except for the OW treatment, which had 32 steers while on pasture. Cool-season pastures were divided into 24, 0.688 hectare paddocks while the warm-season pastures consisted of 16, 0.405 hectare paddocks. Individual steer weights were obtained in 28 day intervals and daily DMI was recorded throughout feedlot finishing. Steers were fed to 567 kg and harvested at which time carcass measurements were obtained. Treatment did not influence pasture ($P > 0.97$) or feedlot gains ($P > 0.37$) for the JC, OC, and OW treatments. The DF steers had higher overall ADG ($P < 0.001$) and lower feedlot daily DMI ($P < 0.03$) compared to the OW treatment. Furthermore, treatment did not have a significant influence on carcass characteristics. Using 10 year averages for purchase price, live and carcass price, and feed ingredient prices, the DF, JC, and OC treatments were the most profitable and the OW treatment was least profitable ($P < 0.001$). These results indicate that both cool- and warm-season pastures, provided to cattle for varying lengths of time prior to feedlot finishing, do not negatively affect carcass composition, and that cattle that are fed on a cool-season pasture is an economically feasible alternative to direct placement of cattle into feedlot finishing programs.

Key Words: Rotational stocking, Cattle finishing, Cool- and warm-season grass

82 Effect of stocking rate and corn gluten feed supplementation on the performance of young beef cows grazing winter stockpiled tall fescue-red clover. R. Driskill, J. R. Russell*, D. R. Strohbehn, and D. G. Morrical, *Iowa State University, Ames*.

A winter grazing experiment was conducted to evaluate the BW and body condition scores (BCS) of bred two-year old cows grazing stockpiled forage at two stocking rates and two levels of supplementation during winter. Two 12.2-ha blocks containing 'Fawn' endophyte-free tall fescue-red clover were each divided into four pastures of 2.53 or 3.54 ha. Hay was harvested from the pastures in June and August of 2003 and 2004 and N was applied at 44.8 kg N/ha at the initiation of stockpiling in August. On October 22, 2003, and October 20, 2004, twenty-four Angus-Simmental and Angus two-year old cows were allotted by BW and BCS to strip-graze for 147 d at 1.19 or 0.84 cow/ha and eight similar two-year old cows were allotted to two dry lots and fed tall fescue-red clover hay. Corn gluten feed was fed to maintain mean BCS of 5 or 4.33 (9-point scale) for cows in the high and low supplementation levels, respectively, or when weather prevented grazing. Mean concentrations of CP in yr 1 and 2 and IVDMD in yr 1 were greater ($P < 0.10$) in hay than stockpiled forage over the season. At the end of grazing, cows fed hay in the dry lots had greater ($P < 0.05$) BCS in yr 1 and greater ($P < 0.10$) BW in yr 2 than grazing cows. Grazing cows in the high supplementation treatment had greater ($P < 0.10$) BCS (yr 1) and BW (yr 2) than cows grazing at the low supplementation level. Cows in the dry lot were fed 2565 and 2158 kg DM hay/cow. Amounts of corn gluten feed supplemented to cows in yr 1 and 2 were 46.2 and 60.8 kg/cow and did not differ between forage, stocking rate or supplementation treatments in either year. Estimated production costs were greater for cows in the dry lots due to greater amounts of harvested feeds fed.

Key Words: Beef cows, Stockpiled forage, Corn gluten feed

83 The variance of residual feed intake in purebred Hereford heifers fed a forage diet. L.S. Miller*, M. S. Kerley, and W. H. Kolath, *University of Missouri, Columbia*.

The primary emphasis in measuring gain efficiency of cattle has been in the feedlot, with less emphasis on research evaluating the variation between females within a breeding herd. Therefore, the objective of this experiment was to determine the variation in residual feed intake of 42 Hereford heifers. These heifers were acquired from 19 breeders in Missouri and represented approximately 70 separate cow lines. The heifers were provided ad libitum alfalfa/grass hay for a period of 51 days during which time individual animal intake was recorded using the GrowSafe® feed intake system. Residual feed intake values were calculated and used as a phenotypic measure of efficiency. The five heifers with the lowest RFI values consumed 14.57 ± 3.89 kg/d while the five heifers with the greatest RFI values consumed 27.20 ± 4.86 kg/d. When expressed as a percent of body weight (PBW), forage intake for the lowest RFI group was 2.50 PBW and for the highest RFI was 5.05 PBW. The efficiency of gain differed between the lowest and highest RFI groups. There was no difference ($P > 0.05$) between groups in body condition score (average body condition score 5.5) or gain (0.74 kg/d vs 0.64 kg/d). Annually heifers with the higher RFI would consume approximately 4600 kg more forage than the heifers with low RFI values. These findings were

consistent with previous research conducted in our laboratory that found intake of high RFI feedlot calves were greater than low RFI calves. The selection for animals that have low RFI values should impact carrying capacity of pastures.

Key Words: Cattle, Feed efficiency, Intake

84 Effect of barley particle size on intake, growth, and gain efficiency of steers fed growing diets. D. Larson*, M. Bauer, and G. Lardy, *North Dakota State University, Fargo*.

A study was conducted to evaluate the effect of barley particle size on growth, intake, and gain efficiency of steers fed growing diets. Previous research indicates that more extensive processing of barley results in reduced DMI, increased ADG, and improved G:F ratio. One hundred, forty-four crossbred steer calves (initial BW = 334 ± 16 kg) were blocked by initial weight and assigned randomly to one of three treatments. Treatments consisted of barley (42.6%, DM basis) reduced to 1708 (coarse-rolled barley, CRB), 1395 (medium-rolled barley, MRB), or 1146 (fine-rolled barley, FRB) Mm, approximately 61, 50, and 41% of whole barley (2800 Mm), respectively, fed in a total mixed ration. The ration DM also contained pressed wet sugar-beet pulp (35%), chopped mixed hay (15%), concentrated separator by-product (5.0%), and a supplement (2.4%). Diets were formulated to provide 12.5% CP, 27.5 mg/kg monensin, and 11 mg/kg tylosin. Calves were fed for 61 d, body weight was measured approximately every 28 d, feed intake was recorded daily, and feed refusal was recorded weekly. Steers were implanted on d 0 of the trial. Data were analyzed using the MIXED procedure of SAS and mean separation by LSD along with linear and quadratic contrasts ($P = 0.05$). Body weight was similar ($P = 0.39$) between treatments at d 0 (334 ± 16 kg), d 29 (384 ± 16 kg), and d 61 (430 ± 15 kg). Average daily gain (1.50 ± 0.03 kg/d) also did not differ ($P = 0.19$) among treatment groups. Dry matter intake (9.20 ± 0.33 kg) was similar ($P = 0.23$) across treatments. Apparent dietary NEM (1.83 ± 0.03) and NEg (1.19 ± 0.03) were similar ($P = 0.74$) among treatments. Finally, G:F (0.163 ± 0.01) was not different ($P = 0.92$) among treatments. Although there were no differences, calves consuming the FRB diet had a tendency to have greater DMI ($P = 0.11$) and ADG ($P = 0.07$) in a linear fashion when compared to those consuming the CRB diet. We concluded that under the conditions of this study, barley grain ground to 1146 Mm appears to have equal feeding value to barley grain rolled to 1708 and 1395 Mm in a growing ration.

Key Words: Barley, Bovine, Particle size

85 Effect of pulse grains on rumen fermentation, digestion, and microbial protein synthesis in receiving diets for beef cattle. T. Gilbery*¹, G. Lardy¹, S. Navarro¹, M. Bauer¹, and V. Anderson², ¹North Dakota State University, Fargo, ²North Dakota State University, Carrington.

Abstract: Eight Holstein and 8 Angus crossbred steers (509 ± 137 kg initial BW) fitted with ruminal and duodenal cannulae were utilized in a completely randomized design experiment to evaluate the effects of pulse grain inclusion in growing diets on intake, ruminal fermentation,

and site of digestion. Treatments contrasted pulse grains with corn and canola meal (CON) as the grain component in backgrounding diets fed ad-libitum as a total mixed ration (TMR). Diets contained 50% grass hay, 5% concentrated separator byproduct, 4% supplement, and 41% corn and canola meal or pulse grain and corn. Treatments included: 1) corn and canola meal (control; CON); 2) field pea (FP); 3) lentil (LEN); and 4) chickpea (CP). Diets were formulated to contain 12% CP and contained a Ca: P ratio of 2:1. Contrasts between the CON and treatments containing pulse grains were analyzed. There were no differences among treatments for DMI (12.58 kg; 2.53% of BW, $P = 0.30$). No treatment effects were observed when pulse grains replaced corn and canola meal for OM intake, apparent ruminal and total tract OM digestion ($P = 0.42$). Crude protein intake, microbial CP flow, and total tract CP flow ($P = 0.52$ to 0.93) did not differ. Total tract ADF ($P = 0.006$) and NDF ($P = 0.02$) digestion were greater for the FP treatment vs CON. Total VFA was lower for the FP ($P = 0.006$) and LEN ($P < 0.001$) treatments compared to the CON. Ruminal pH and NH₃ ($P < 0.11$) were not different among treatments. This study indicates pulse grains are similar in OM and CP digestion compared to corn and canola meal in growing diets. Due to the moderately high levels of protein and energy that pulse grains contain, they are viable alternative for replacement of cereal grain and protein supplements in growing diets for beef cattle.

Key Words: Pulse grains, Digestibility, Steers

86 Effects of processing field peas for feedlot diets, creep feed, and gestating beef cows. V. Anderson, J. Schoonmaker, and B. Ilse*, *North Dakota State University, Carrington.*

Field peas (*Pisum sativum* L.) are a nutrient dense (24% CP, 136 Mcal/kg NEg), palatable grain legume. The supply of this new feed grain is increasing in the Northern Plains. Three experiments were conducted to determine the effects of processing field peas for beef cattle. Yearling feeder heifers ($n=127$), gestating cows ($n=102$), and nursing calf/cow pairs ($n=111$) were each used in one of three studies. In each study, three field pea processing treatments (and respective average particle sizes) were used: ground with a hammer mill (700 microns), dry-rolled (3100 microns) and whole (9250 microns). In a 112 day feedlot finishing study, field peas were fed at 27 % of the diet dry matter in a corn based ration to yearling heifers. Dry-rolling improved DM intake ($P < .03$) and gain ($P < .04$) compared to ground or whole peas, which were similar. Dry matter intake averaged 9.62 kg/d for ground, 10.34 kg/d for dry-rolled, and 9.67 kg/d for whole field peas. Feedlot heifers gained 1.41 kg/d on ground, 1.54 kg/d on dry-rolled, and 1.34 kg/d on whole field pea diets. No differences ($P = .46$) in feed efficiency were observed. Creep-fed calves (peas included at 40% of the diet DM) tended to gain faster ($P = .10$) with dry-rolled field peas (1.50 kg/d) versus ground (1.41 kg/d) or whole (1.42 kg/d) in a 56 day trial. In an 87-d study, gestating cows fed 20% field peas in a wheat straw-corn silage based diet tended to gain faster when fed dry-rolled peas ($P = .13$) compared to ground or whole field peas. Daily gain averaged 0.49, 0.58, and 0.52 kg for ground, dry-rolled or whole peas, respectively. Results suggest that processing field peas by dry rolling may increase DM intake and gain over grinding or feeding whole in three different classes of beef cattle diets.

Key Words: Field peas, Processing, Beef cattle

87 Feeding dried distillers grains with solubles as a replacement for soybean meal and a portion of the corn in finishing wether diets. T. J. Huls*, A. J. Bartosh, J. A. Daniel, R. D. Zelinsky, J. E. Held, and A. E. Wertz-Lutz, *South Dakota State University, Brookings.*

Increasing availability of by-products such as dried distillers grains with solubles (DDGS) and soyhulls (SH) has resulted in economically-priced feed ingredients. The objective of this experiment was to determine if replacing soybean meal (SMB) and a portion of the corn with DDGS would result in similar growth performance, carcass characteristics, and no increase in incidence of acidosis, bloat, or urinary calculi in market wethers fed a high-grain finishing diet where SH were the only source of roughage. Crossbred wethers ($n = 40$) were allotted by weight to ten pens (four wethers per pen) so that mean initial weight of the wethers within a pen was similar (43.4 ± 0.54 kg). Dietary treatments were SH-CORN-DDGS or SH-CORN-SBM, and each was assigned randomly to five pens of wethers. Diets were balanced to have similar CP (14.6%), ME (3.4 Mcal/kg), and calcium:phosphorous (2:1), and ammonium chloride (0.5%) was included in the diet. Diets were pelleted and delivered through self-feeders. Feed offerings and feeder contents at trial termination were weighed, and DMI was calculated based on these data. Initial and final weights were the average of two consecutive weights. These data were used to calculate ADG and gain:feed for the 64-d finishing period. At trial termination, carcass measurements were recorded. Growth performance, DMI, and carcass data were analyzed statistically using the MIXED procedure of SAS. Differences resulting from dietary treatment were separated by least squares means. Average daily gain (0.29 ± 0.02 kg/d), DMI (1.62 ± 0.04 kg/d), gain:feed (0.18 ± 0.01), and carcass characteristics did not differ ($P = 0.05$) between dietary treatment groups. Wethers did not exhibit symptoms of acidosis, bloat, or urinary calculi regardless of dietary treatment. In summary, DDGS is a suitable substitute for SBM and a portion of the corn in a finishing wether diet where SH are the only source of roughage.

Key Words: Dried distillers grains with solubles, Soyhulls, Wethers

88 The effects of different ruminal degradable protein (RDP) sources on fermentation of corn-based diets in continuous culture. C. J. Fu*, J. H. Porter, and M. S. Kerley, *University of Missouri, Columbia.*

Experimentation with a single-phase continuous culture system (CC) operated at a 0.04/hr fractional dilution rate (D) was conducted to determine the effects of rumen-degradable protein (RDP) source on rumen fermentation when cultures were fed all-concentrate diets. The microbial efficiency (MOEFF), microbial nitrogen flow, VFA levels (include lactate), fermentation pH, and nutrient digestibility were determined. Treatments consisted of five different RDP sources and a control (no added RDP) diet. The basal/CONTROL diet (on DM basis) was corn (100%), and SBM (12.8%), DDGS (38.3%), CASEIN (4.1%), UREA (1.3%), and BIURET (1.48%) were used as sources of RDP. The level of dietary RDP was 8.0% on a DM basis except the CONTROL diet. The results indicated that NPN and RDP (true protein) both influenced VFA and lactic acid production, and therefore pH. The CONTROL, UREA, and BIURET treatments resulted in lactic acid concentration similar to that of CASEIN (35.4, 43.5, 38.2 vs 32.9 mM, $P > 0.05$) which were much higher ($P < 0.01$) than that of SBM and DDGS treatments (1.1 and 0.1 mM). The BIURET diet had highest VFA among the

treatments (183.4 mM, $P < 0.01$), followed by SBM, CONTROL, and CASEIN (163.6, 163, and 157.0 mM) which were higher ($P < 0.01$) than that of UREA and DDGS (142.5 and 121.7 mM). The acetate and propionate ratio showed three different ($P < 0.01$) fermentation patterns (SBM and DDGS, 1.56 and 1.27; CASEIN and UREA, 4.53 and 3.87; BIURET and CONTROL, 10.94 and 10.31). The SBM and DDGS appeared to alter the dominant species of bacteria present, either by reducing the lactic acid producing species or increasing the lactic acid fermenting species, resulting in an increased pH (SBM and DDGS vs others, $P < 0.01$) and improved MOEFF compared to the other diets ($P < 0.01$). Concluded from this experiment was that the source of RDP was important in controlling ruminal pH and fermentation.

Key Words: All-concentrate diets, RDP, Rumen fermentation

89 Effect of heat stress on rumen microbial growth and efficiency in vitro. D. Srichana*, J. H. Porter, M. S. Kerley, M. R. Ellersieck, and J. N. Spain, *University of Missouri, Columbia*.

During periods of heat stress, intraruminal temperature is increased concurrent with changes in the animal's thermal status. Two experiments were conducted to measure effects of increased thermal temperature on microbial growth and fermentation. A batch culture experiment was conducted. Culture flasks were charged with rumen fluid, buffer and feed. Flasks were then incubated in one of three temperatures: 39°C (low), 40°C (medium) and 41°C (high). Optical density (OD), pH and fermentation end products were measured every 6 h through 36 h. The

experiment was designed as a completely randomized arrangement of treatments with 8 replicates per treatment. Optical density increased overtime with no difference among treatments until 12 h. At 12 and 24, OD was highest ($P < 0.05$) for medium incubation temperature (1.59 and 1.56), with low temperature intermediate (1.43 and 1.54) and high temperature having lowest OD (1.41 and 1.38). At 12 h, medium temperature had highest total VFA concentration (86.1 versus 82.2 (high) and 78.0 (low)). By 24 h high temperature had lowest total VFA (133.0 versus 139.6 (low) and 141.1 (intermediate)). Ammonia concentrations exhibited treatment differences at 24 h with low heat having lowest concentration (23.0 mM) compared to intermediate (25.6 mM) and high (27.4 mM). At 36 h incubation medium (41.8 mM) and low (40.8 mM) heat having highest ammonia with high heat lower (36.6 mM). A continuous culture study was conducted to measure effects of thermal stress on microbial efficiency. Fermentors ($n = 5$ per treatment) were incubated at 39°C (low), 40°C (medium) and 41°C (high) temperatures. Fermentors were allowed to equilibrate for 3 days followed by a 3 day collection phase. Thermal conditions did not alter the flow of bacteria N, OM digestibility or microbial efficiency. Total VFA, concentration of VFA and ammonia were not changed by incubation temperature. Bacterial composition (%N and purine mg/gDM) was changed with elevated incubation temperature decreasing %N and purine in bacterial DM. While batch culture results suggest medium heat (40°C) was optimal, results from continuous culture system found no differences in microbial growth or efficiency. The change in bacterial composition does suggest adjustment may be necessary in accurately predicting flow of microbial DM during heat stress.

Key Words: Heat stress, Microbial growth, Microbial efficiency

Swine Extension

90 Michigan swine finishing management program. T. Guthrie*, R. Bates, D. Rozeboom, G. May, and B. Straw, *Michigan State University, East Lansing*.

In Michigan, more than 50% of market pigs are produced under contract. The objective of this program was to offer an informative and educational program for contract swine producers and owner operators which would allow them to improve their knowledge regarding finishing pig management practices through a combination of self-study and live workshops. Upon registration, participants ($n = 217$) received the following: National Pork Board (NPB) Grower Finisher Management (GFM) CD, MSU Pork Quality Assurance CD, a NPB GFM CD self-test and evaluation form, and instructions for completing an on-farm assessment. Participants reviewed the NPB GFM CD and conducted an on-farm assessment before attending one of nine state-wide workshops which emphasized topics relevant to the Michigan swine industry. After the completion of each respective workshop, participants returned their completed on-farm assessment exercise and NPB GFM CD evaluation, and completed an evaluation of the workshop. Sixty seven percent of respondents were contract growers or farm employees, 21.7% were owner operators and 11.2% were allied industry representatives. Swine industry experience of respondents ranged from 3 months to 47 years with a median of 12 years ($n = 89$). The mean number of hogs marketed by operation was 27,318 ($n = 79$). Sixty two percent of respondents indicated that they preferred video tapes/CD ROMS for continuing education, 39% indicated they preferred live

workshops and hard copy media and 87% indicated that on the job training was the primary method of work place education. On-farm assessments revealed that drinker flow rates were variable (6 to 226 s/473 mL) while 6.1% of drinking devices evaluated had flow rates greater than 50 s per 473 mL. Feed particle sizes of > 900 microns were reported by 32% of respondents. Feeder adjustment was assessed with 77% of respondents reporting 50% or less of feed pan coverage. Respondents gave an overall rating of 96.8% for relevance of the program and 71.6% of respondents reported that they would implement changes using information learned during the program.

Key Words: Finishing pigs, Education, Management

91 Evaluation of different mixed model nonlinear functions on pigs fed low nutrient excretion diets. A. Schinckel*, M. Einstein, R. Hinson, B. Richert, J. Radcliffe, P. Preckel, and S. Pence, *Purdue University, West Lafayette, IN*.

Three nonlinear growth functions were evaluated relative to data on barrows ($n=108$) and gilts ($n=105$) fed diets designed to reduce Nitrogen and Phosphorous excretion. The pigs were weighed at birth and at approximate biweekly intervals from 62 to 147 days of age and then weekly to 190 days of age. Mixed models including pig specific random effects were evaluated for the Bridges, Weibull, and Generalized Michaelis-

Menten (GMM) functions. Two pig specific random effects were included in each function, one for predicted mature BW and one variable associated with the age in which maximum ADG was achieved. Alternative analyses were completed in which a random effect for a third parameter was predicted as a linear function of the random effect for mature BW. The alternative analyses resulted in improved likelihood statistics, substantially smaller SEs for the between pig variance in mature BW and decreased SDs for the predicted age to achieve specific target market BWs. The three functions provided similar likelihood statistics, residual standard deviations, predicted BW^â™s and predicted mean age (140 days for barrows and 134 days of age for gilts) and mean BW (83 kg for barrows and 73 kg for gilts) at which maximum ADG was achieved. The Weibull and Bridges functions predicted that three barrows and six gilts had mature BWs of less than 130 kg. The GMM function allowed for more gradual growth to 50 percent greater mature BWs than the Weibull and Bridges functions. The GMM equation allows for asymmetric sigmoidal growth and in some cases may provide a better fit to the BW data of pigs.

Key Words: Mixed effects model, Nonlinear growth functions, Pig growth

92 Analysis of the association of number of piglets born alive with sow level factors and season of farrowing. S. S. Anil*, L. Anil, and J. Deen, *University of Minnesota, St. Paul.*

Data from 152,015 parity records of sows from 14 US farms were retrieved from PigCHAMP database for the period from 2002 to 2004 and analyzed to evaluate the association of number of piglets born alive with parity, season and year of farrowing, litter attributes (number of stillborn and mummies) and the number of services required for that litter. The farm was included in the analysis as random effect (Proc mixed, SAS version 9.1). For analysis, parity was categorized as parity 1,2,3,4,5 or >5, number of services as 1 or >1, stillborn and mummies as present or absent and season of farrowing as four quarters (Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec). Parity 1 sows had less (P<0.05) number of piglets born alive compared to parity >5 sows. Sows of parities 2-5 had higher (P<0.001 for all) number of piglets born alive than sows of parity >5. Sows with no stillborn or mummies had less (P<0.001 for both) number of piglets born alive. Sows those farrowed during other quarters had higher (P<0.001 for all) number of piglets born alive than those farrowed during Oct-Dec. Compared to 2004, the number of piglets born alive was less in 2003 and higher in 2002 (P<0.001 for

both). The number of services required for a litter had no effect on the number of piglets born alive in that litter. The study indicated that the number of piglets born alive is associated with both sow level and seasonal factors.

Key Words: Born alive, Farrowing, Season

93 Effect of feeding LuctaPlus in improving performance of weaned pig diets. A. L. Smith*, K. J. Stalder, T. V. Serenius, T. J. Baas, and J. W. Mabry, *Iowa State University, Ames.*

The objective of this study was to quantify the effects of weaning age and feeding LuctaPlus (Lucta USA, Northbrook, IL) on nursery pig performance. LuctaPlus is a product with a blend of flavors, acidifiers, and enzymes added to a diet to lower the inclusion rate of more complex ingredients in complex nursery diets. The study utilized Danbred N.A. (Columbus, NE) barrows and gilts (n=672) from a commercial maternal line multiplication herd. The trial was conducted as a 2 x 2 factorial experiment with main effects of weaning age and dietary feed treatment. Two weaning age groups included a 15 d average (pigs weaned at 14, 15, or 16 d of age) and a 20 d average (pigs weaned at 19, 20 or 21 d of age) age group. Pigs received 1.25 kg of a 23% CP pellet, 6.14 kg of a 21.2% CP diet, 12.57 kg of a 18% CP diet and the remainder a 17.3 % CP diet in the control feed regimen. Two dietary treatments included the control diet and the control diet modified to include LuctaPlus as 0.5% of the diet fed only in phase II. Pigs (mixed sexes) were housed in each 2.44 x 3.05 m pen. Feed delivery was recorded on a pen basis throughout the nursery trial. Statistical analysis was conducted using PROC MIXED of SAS (Cary, NC). The model for ADG included fixed effects of weaning age group, dietary feed treatment and the interaction between feed treatment and weaning age group. When the fixed effects were a significant source (P < 0.05) of variation, differences between levels of fixed effects were analyzed using the PDIF option of SAS. Pigs weaned at a 20 d average age had a greater (P < 0.01) nursery ADG (0.79 vs. 0.71 kg/d) when compared to pigs weaned at a 15 d average age. The main effects of dietary feed treatment (P < 0.21) and the interaction of dietary feed treatment and weaning age group (P < 0.98) were not significant sources of variation for ADG in the 40 d nursery phase. Altering nursery feed regimens to include LuctaPlus did not affect nursery growth performance.

Key Words: Swine, Weaning age, Enzyme

Billy N. Day Symposium - Implications of Prenatal Physiology on Modern Pork Production

94 What has been learned about uterine capacity in the pig from genetic selection experiments? R. Johnson*, *University of Nebraska, Lincoln.*

Twenty-four generations of selection for litter size and its components has been practiced. Lines include: I, selected 11 generations for ovulation rate (OR) and embryonic survival (ES) followed by 13 generations of selection for litter size (LS); C1 selected randomly for 24 generations; IOL, derived from Line I at Generation 8 and selected 8 generations for OR and LS followed by 4 generations of LS selection; COL, derived

from Line C1 at Generation 8 and selected as IOL was, and C2, derived from C1 at Generation 8 and selected randomly. Selection in Lines IOL and COL was applied in two stages based on the ovulation rate/uterine capacity model (OR/UC); 2nd stage selection for litter size in high ovulating gilts was expected to directly select for increased UC. Lines IOL and COL were crossed at Generation 20 to form Line 45 which was subsequently selected for LS through Generation 24. Relative to Line C1, responses in Line I at Generation 11 were 7.4 OR, 3.8 fetuses at 50 d of gestation, 2.3 fully formed pigs (FF), and 1.1 live pigs (BA) at birth. Responses in I at Generation 19 were 3.53 FF and 2.53 BA. At Generation 24, line means are: I = 14.06 FF and 10.4 BA, Line C1 = 8.75 FF and

7.83 BA. At Generation 16, responses in Line IOL relative to Line C2 were 2.08 OR, 2.64 FF, and 1.68 BA; responses in Line COL were 2.32 OR, 2.16 FF, and 1.92 BA. Line means at Generation 23 were: L45 = 13.2 FF and 11.4 BA, Line C2 = 8.63 FF and 7.91 BA. With the OR/UC model, predicted UC in Lines IOL, COL, and C2 at Generation 16 were 16.3, 15.6, and 10.5 fetuses, respectively. Responses in UC in later generations cannot be predicted because OR was not recorded. Balancing selection for OR and UC to increase LS based on the OR/UC model appears to be more effective than index selection for OR and ES or direct selection for LS. Direct LS selection is expected to be most effective in populations with high mean OR but average LS. QTL scans in these lines have identified one chromosomal position affecting OR and 14 others affecting FF, BA, or numbers of mummified and stillborn piglets.

Key Words: Pigs, Selection, Litter size

95 What we have learned about prenatal physiology in the pig from uterine crowding experiments. J. Vallet*, B. Freking, J. P. Kayser, R. Christenson, and K. Leymaster, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

The factor most limiting to litter size is becoming uterine capacity, the number of fetuses that the uterus can maintain until farrowing. Intrauterine crowding does not appreciably limit litter size until after day 30 of gestation, with most fetal loss occurring between day 30 and 40 of gestation, although further losses occur in later gestation. We have used unilateral hysterectomy-ovariectomy (UHO) to study the effects of intrauterine crowding on the uterus, fetus and placenta. Studies indicated few effects on uterine function, measured as endometrial protein secretion. In UHO gilts, fetal hematocrits decreased with fetal weight, suggesting that small fetuses were anemic. This observation led to the discovery of a polymorphism in the porcine erythropoietin receptor gene that is associated with litter size. Fetal brain growth is relatively resistant to intrauterine crowding, particularly during late gestation. In contrast, growth of the fetal heart is more resistant to crowding during early pregnancy. Further work on the mechanisms that shunt nutrients to various organs could provide improvements in litter size. Finally, several previous studies indicate that placental efficiency (fetal weight:placental weight ratio) increased due to intrauterine crowding. Other studies suggest that placental folding may influence the efficiency of the placenta. The depth of placental folding increased in placentas associated with the smallest fetus in a litter. This occurred at the expense of the fetal stroma layer surrounding the placental interface. During late gestation in some small fetuses, the placenta may have no further room to increase folding, potentially resulting in death. This could

explain fetal losses due to intrauterine crowding that occur during late gestation. In summary, although the full effects of intrauterine crowding are still unclear, clues are beginning to unfold that could result in improvements in litter size in swine.

Key Words: Uterus, Placenta, Fetus

96 Fetal programming: what do we know and what are the implications for the swine industry? R. Anthony*^{1,2}, ¹Colorado State University, Fort Collins, ²University of Colorado Health Sciences Center, Aurora.

The concept of “fetal programming” or the “fetal origins of adult disease” hypothesis originated with extensive epidemiological studies of various human populations. It is now well documented that growth-restricted infants, or infants of normal birth weights that experience an altered growth trajectory sometime during gestation, have a greater predisposition for coronary heart disease, hypertension, obesity, and type 2 diabetes as adults. These disease states are inter-related, and collectively they have been designated as the Metabolic Syndrome. Fetal growth restriction can result from a variety of causes, the majority of which cause functional placental insufficiency and a failure to provide adequate nutrition to the developing fetus. Consequently, growth-restricted fetuses are often hypoglycemic, hypoinsulinemic and hypoxic, and in more severe cases the fetus is also hypertensive and acidemic. Impaired organ growth and development, particularly with the abdominal organs, occurs in these individuals, altering postnatal growth rates and metabolic regulation as these offspring age. While these adult disease states are not often a concern in livestock production, altered metabolic homeostasis as a result of impaired fetal growth may well impact livestock production efficiency. A number of animal models, primarily in rodents and sheep, have been developed and used to investigate fetal growth restriction and the postnatal consequences, providing considerable insight into the fetal and postnatal manifestation of fetal growth restriction and the development of the metabolic syndrome. While pigs have not been used as extensively as sheep and rodents, recent studies comparing low-birthweight (<1.5 kg) to high-birthweight (>1.5 kg) pigs provide evidence for “fetal programming” and its impact on adult metabolism. Low-birthweight pigs exhibit altered juvenile cardiovascular function, impaired glucose tolerance and insulin resistance as adults, as well as increased adult fat depth. These results suggest impaired fetal growth may well have a significant impact on growth and composition of swine, thereby impacting the efficiency of swine production.

Key Words: Swine, Fetal growth restriction, Metabolic syndrome

Dairy Extension Symposium - Starch Utilization by Ruminants

97 Laboratory methods of analysis for feedstuff starch content and availability. M. B. Hall*, *U. S. Dairy Forage Research Center, USDA-ARS, Madison, WI.*

The relationships that starch has with profitable production or with health disorders in cattle advise closer accounting of its quantity and

quality in diets. Native starch is an A-(1-4)-linked-glucan with A-(1-6) linked branch points found in crystalline granules in plants. In feedstuffs, it can be analyzed by enzymatic hydrolysis, or by polarimetry, though both suffer from interferences. Analysis by enzymatic hydrolysis requires gelatinization, hydrolysis with enzymes specific for starch and detection of glucose. Gelatinization breaks hydrogen bonds and the

crystalline structure of starch granules, making starch more available to enzymatic attack. It has been accomplished using water + heating, alkali, and dimethyl sulfoxide among other methods. Enzymatic hydrolysis requires enzymes of adequate specificity to release glucose only from starch, and appropriate conditions to take hydrolysis to completion. Heat-stable, α -amylase, an endoamylase, can partially hydrolyze starch before amyloglucosidase, an exoamylase, completes the hydrolysis to glucose. Detection of released glucose is best done by assays specific for glucose. Recoveries of pure starch often range from 90% to 98% on a dry matter basis, and analyses typically have a repeatability of + 2% units. Pure starches from different plant sources may differ in recovery values. Most oft noted errors include use of enzyme preparations that release glucose from non-starch molecules, lack of correction for free glucose, and incomplete hydrolysis. Indices of rate and potential extent of digestibility of starch could be useful to formulate diets that promote both good production and health. Assays using enzymatic glucose release from starch and disappearance of starch during microbial fermentation have been used to assess these characteristics. Method of sample processing for analysis affects the results. Relative indices of rate or extent of starch digestion could be useful in the field. However, for these assays to be applied to describing quantitative differences among starch sources, they need to be linked to a ration formulation or evaluation system that is calibrated to the values they provide.

Key Words: Starch, Analysis, Nonfiber carbohydrate

98 Applied aspects of starch in dairy cattle feeding programs. R. Shaver and P. Hoffman*, *University of Wisconsin, Madison.*

Dairy cattle nutritionists have long used non-fiber carbohydrate (NFC) as a quasi-nutrient. However, NFC is a calculated value comprised of

varying proportions of starch, sugar, soluble fiber, organic acids, and is subject to errors associated with analyzing the five nutrients (CP, NDF, NDFCP, Fat, Ash) used to calculate NFC. Components of NFC vary greatly in their ruminal degradability as well as the end-products of their degradation in the rumen. Starch is the component of NFC most closely related to ruminal propionate production and thus likely of highest interest from the standpoint of ruminal pH, milk fat content, and sub-acute rumen acidosis. Dose response trials evaluating dietary starch content versus lactation performance are limited. Dietary starch allowances commonly used in the field range from 25% to 30% (DM basis) depending on the content of physically-effective NDF and (or) the ruminal degradability of starch sources in the diet. Future research aimed at this dose response and on these interactions is needed. Although the Dairy NRC 2001 summative energy equation was based on NFC, starch rather than NFC is being used in summative energy equations by many commercial feed testing labs especially for corn silage. However, determining digestion coefficients for starch to use in summative energy equations has been difficult. The Dairy NRC 2001 uses arbitrary processing adjustment factors, while the MILK2000 corn silage evaluation program varies the starch digestion coefficient by regression using whole-plant DM and kernel processing as factors. Both approaches are limited in their ability for detecting potential variation in starch digestibility across a wide array of samples, and novel lab assays are needed. Ruminant in-vitro or in-situ degradation, either alone or in combination with in vitro post-ruminal enzymatic digestion of the ruminal residues, have been explored by some research groups. We recently developed an enzymatic lab assay, Degree of Starch Access (DSA), which is sensitive to differences in particle size, moisture content, and vitreousness of corn-based feeds. Field and in vivo evaluation of these assays in dairy cattle feeding programs is needed.

Key Words: Starch, Digestion, Dairy cattle

Growth and Development, Muscle Biology, and Meat Science Symposium - Components of Meat Quality

99 Crossing the line between muscle and meat: The influence of muscle cell physiology on meat quality. E. Huff-Lonergan* and S. Lonergan, *Iowa State University, Ames.*

Efforts designed to develop an understanding of the mechanisms behind the manifestation of many meat quality attributes must first define the postmortem biology of muscle tissue. Only by having a good understanding of these mechanisms can investigators efficiently solve quality inconsistencies that face the meat industry now and in the future. Muscle is an extremely intricate and dynamic tissue that depends on highly coordinated interactions between numerous myofibrillar, cytoskeletal and sarcoplasmic proteins to maintain its function and integrity. Likewise, meat is also a highly complex substance that depends upon many of the factors present in living muscle for its quality attributes. Therefore, it is imperative that researchers investigating fresh meat quality have an understanding of how muscle proteins (both structural proteins and enzyme systems) function and how these proteins respond to intracellular changes occurring during the early postmortem period. The conversion of muscle to meat results in a set of conditions in postmor-

tem muscle that is vastly different from those in living tissue. As muscle is converted to meat, many changes occur, including: 1) a gradual depletion of available energy, 2) a shift from aerobic to anaerobic metabolism, favoring the production of lactic acid and resulting in tissue pH decline, and 3) a rise in ionic strength, in part, because of the inability of ATP-dependent calcium, sodium, and potassium pumps to function. Another change that occurs in postmortem muscle is increased oxidation of proteins. Differences in the rate of oxidation and other postmortem changes in muscle tissue are seen when comparing the same muscles between animals and/or carcasses. These differences may arise because of differences in diet, breed, antemortem stress, postmortem handling of carcasses, etc. There are also numerous differences in the way specific muscles undergo many postmortem changes. Therefore, there may be many differences between muscles in their susceptibility to oxidation and other postmortem changes that could be capitalized upon to improve meat quality.

Key Words: Muscle, Meat, Meat quality

100 Adipose tissue, lipids, and meat quality. S. Smith* and D. Lunt, *Texas A&M University, College Station.*

Fat (or lipid) has marked effects on mouthfeel and flavor of meat, which are primary components of palatability. The amount of fat and its fatty acid composition both influence palatability. The kinds of fatty acids present in meat and its cholesterol content also dictate the perceived healthfulness of meat. There are three sources of lipid in meat: the muscle fibers; subcutaneous adipose tissue; and intramuscular (marbling) adipose tissue. Most meat in the market place now is closely trimmed of subcutaneous adipose tissue, so subcutaneous adipose tissue now contributes little to fat and cholesterol intake. Once subcutaneous adipose tissue has been removed, the primary contributor to lipid content of meat is intramuscular adipose tissue. Lean beef, pork, or lamb, in which all subcutaneous and intermuscular (seam) adipose tissues have been removed, contain approximately 1% extractable lipid. The composition of lipids in meat varies in response to diet and the age of the animals at slaughter. The fatty acid composition of pork is especially sensitive to dietary manipulation, whereas that of beef and lamb is affected by the age of the animal and whether the animals are forage or grain-fed. Meat from steers fed a corn-based diet to 525 kg BW had monounsaturated:saturated fatty acid (MUFA:SFA) ratios of 0.91, whereas feeding cattle a hay-based diet to the same BW resulted in meat with a MUFA:SFA ratio of 0.72. Extended feeding (to 650 kg) increased the MUFA:SFA ratio in meat from corn-fed steers to 1.42, but increased the MUFA:SFA only to 1.22 in hay-fed steers. Melting points of lipids from corn- and hay-fed steers raised to 525 kg were 37.9 and 42.8°C, respectively, whereas melting points of lipids from corn- and hay-fed steers raised to 650 kg were 27.8 and 31.3°C, respectively. Cholesterol content of meat increased with BW, but was unaffected by diet. These results indicate that pasture feeding causes harder fat, with lower concentrations of monounsaturated fatty acids. Similar results can be obtained in pork by feeding diets enriched with conjugated linoleic acid. Thus, some production practices can produce meat that may be perceived as less healthful by consumers.

Key Words: Adipose tissue, Fatty acids, Meat

101 Intramuscular connective tissue and its role in meat quality. P. Purslow*, *University of Guelph, Guelph, Ontario, Canada.*

Intramuscular connective tissue (IMCT) components of muscle have a large contribution to the toughness of cooked meat. Three main aspects of how and why this contribution can be highly variable are: 1) Variations in amount, composition and spatial distribution of connective tissues between muscles. Differences in tenderness between different cuts are principally due to variations in IMCT content of the different muscles. This tremendous variation in the expression of a given animal's genome theoretically represents good opportunity for manipulation of expression of connective tissue. 2) Variations during the development, growth, and especially during the physiological ageing or maturing of animals. IMCT guides muscle growth and repair and is a prime route through which some signals for muscle turnover and growth are transmitted to muscle cells. IMCT also coordinates force production between adjacent muscle fibers and accommodates changes in muscle shape upon contraction. These functions are dominant in explaining the variations in IMCT content between muscles with different mechanical

roles in the animal body. Connective tissue becomes stronger and more resistant to solubilisation on cooking as an animal physiologically matures. The appearance of mature, covalent crosslinks coincides with this change in physical properties. The control of turnover of IMCT may be a mechanism to combat this. There is evidence that increased turnover of during compensatory growth increases connective tissue solubility. 3) Variations produced on cooking, and how this may interact with ageing. The connective tissue contribution to meat toughness increases as meat is cooked from raw to approx 50-55°C and decreases thereafter, as shown either from shear force measures on whole meat or directly on IMCT components isolated from cooked meat. Recent publications have again shown that IMCT is degraded during post-mortem ageing. This reduces the strength of IMCT in the raw state. However, as has long been known, this degradation has no effect on the connective tissue contribution to toughness after cooking at temperature of 60°C or higher.

Key Words: Meat texture, Connective tissue, Quality

102 Effect of aging on tenderness of pork loin rib chops derived from Berkshire swine. A. C. Naber*, K. M. Brueggemeier, S. J. Moeller, and H. N. Zerby, *The Ohio State University, Columbus.*

The objective was to determine the effect of post-harvest aging on tenderness of pork loin rib chops derived from high quality purebred Berkshire swine. Thirty-eight purebred Berkshire barrows and gilts fed in a common contemporary group within a traditional swine finishing facility were harvested on a single day in a commercial swine packing facility. Bone-in, fat-on, whole loins from the right-hand side of the carcass were removed at 18 h post-harvest and processed at 24 h post-harvest at OSU. Five, 5.08 cm-thick loin chops were removed between the fifth and last rib, vacuum-packaged and assigned to aging treatments of 1, 4, 7, 14, or 21 days. Chop orientation relative to days aged was approximately as follows: d 21 (5th to 7th rib), d 14 (7th to 9th rib), d 1 (9th to 11th), d 7 (11th to 13th rib), d 4 (13th to last rib). Chops were stored at 0 to 4°C for their designated aging period and then frozen at -5°C. Frozen chops were cut to 2.54 cm, thawed at 2.20°C, and cooked in an Impingement oven set at 109.50°C to a target internal temperature of 71°C. Cooked loin temperature was recorded. Chops were cooled to 20°C and six, 1.27-cm cores were removed parallel to the muscle fiber orientation. Warner Bratzler Shear Force (WBS) measures represented the average of the six cores per chop. The mixed model for WBS included treatment, sex, a covariate for the deviation of cooked temperature from 71°C within a treatment, and a random pig effect. Least squares means for WBS in all age treatments were less than 3.0 kg indicating very desirable tenderness. No differences in WBS were observed when comparing d 1, d 4, and d 7 aging periods. However, WBS declined ($P < 0.001$) for d 14 and d 21 aging treatments when compared with d 1, d 4, and d 7, with no difference detected between WBS for d 14 and d 21 post-harvest. Loins from barrows exhibited consistently less ($P < 0.001$) WBS across age treatments. These results indicate that high quality Berkshire pork is generally tender; however, long term aging can provide additional improvements in tenderness that are most-likely associated with disassociation of proteins in the extra cellular matrix.

Key Words: Pork quality, Tenderness, Aging

103 Relationship between dietary fat and fatty acid composition in backfat of boars and gilts. E. Hallenstvedt*^{1,2}, H. Sterten^{1,2}, and M. Øverland¹, ¹University of Life Sciences, Ås, Norway, ²Felleskjøpet Forutvikling, Trondheim, Norway.

The objective of this study was to investigate the effect of dietary fat sources and sex on fatty acid composition of backfat in cross bred pigs (LY x DD). The experiment comprised 36 boars and 36 gilts (30 kg and 110 kg initial and final BW) from nine litters. Pigs were allotted according to litter, sex and initial weight in a randomized block design. Pigs were limit-fed individually; thus, each pig was an experimental unit. The dietary treatments were barley - soybean meal based and contained either no added fat (control), 6% soybean oil (SO) or 3% SO and 3% fish oil (SO/FO). Samples of the inner and outer layer of the backfat were collected at the P2-location of each pig and analyzed for fatty acid composition. The results showed that dietary fatty acid composition had significant impact on fatty acid composition of backfat. No signifi-

cant interaction was found between diets and sex for any parameters measured. Pigs fed the low fat control had significantly higher content of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) than pigs fed the SO or SO/FO diets. The content of polyunsaturated fatty acids (PUFA) was higher in pigs fed the SO diet compared to pigs fed the control and SO/FO diet. The n-6/n-3 ratio was on average 50% lower in pigs fed the SO/FO diet than pigs fed control or SO diet. Backfat from boars had a significantly higher level of PUFA than backfat from gilts. The results showed a significantly higher level of SFA and significantly lower levels of both MUFA and PUFA in the inner than the outer layer of backfat. In conclusion, the addition of SO and SO/FO to diets increased the level of PUFA, but decreased the level of MUFA and SFA in the backfat. Furthermore, the SO/FO diets resulted in the lowest n-6/n-3 ratio. Boars had a higher level of PUFA in the backfat, but both sexes reacted similarly to the dietary treatments.

Key Words: Pigs, Dietary fat, Fatty acid composition

Nonruminant Nutrition - Additives and Gut Modifiers

106 Influence of L-carnitine on gilt and fetal growth characteristics at three gestation lengths. K. R. Brown*¹, R. D. Goodband¹, M. D. Tokach¹, S. S. Dritz¹, J. L. Nelssen¹, J. E. Minton¹, J. C. Woodworth², and B. J. Johnson¹, ¹Kansas State University, Manhattan, ²Lonza, Inc., Allendale, NJ., Allendale, NJ.

Gestating gilts (n=59; BW=137.7 kg) were used to determine the effects of dietary L-carnitine on gilt and fetal growth characteristics at d 40, 55, and 70 of gestation. Gilts were fed a gestation diet once daily (1.75 kg) with a 50-g top dress containing either 0 (control, n=30) or 88 mg (50 ppm) of L-carnitine (Carn, n=29) from breeding through d 40, 55, or 70, at which time gilt BW, backfat, and blood collection occurred and fetuses were collected for fetal trait measurements. No differences between treatments were observed for BW or estimated protein or fat mass at any gestation length, but gilts fed Carn were numerically heavier (170.3 vs. 166.2 kg) than control gilts on d 70. Gilts fed Carn tended to have greater (P=0.10) backfat at d 40 gestation. Insulin-like growth factor I (IGF-I) concentrations decreased (P<0.01) from d 0 to 70 for all gilts with no differences between treatments. At breeding, no differences were observed in circulating total and free Carn, but were increased (P<0.01) on d 40, 55, and 70 for gilts supplemented Carn. Total litter size, total litter weight, fetal number in the right (R) and left (L) uterine horn, crown to rump length (CRL) of the fetuses and total number of corpus lutea did not differ among treatment within gestational length. Total litter weight, average fetal weight, CRL, and fetal IGF-II increased (P<0.05), but total fetal number and fetal number in the R and L uterine horn decreased (P<0.05) as gestational length increased. Fetuses from gilts fed Carn tended to be heavier (P=0.06) at d 70 than fetuses from control gilts (236.6 vs. 217.7 g) and fetal IGF-II was lower (P=0.09) at d 70 in gilts fed Carn compared with control gilts (17.6 vs. 22.9 ng/mL). These results indicate that L-carnitine supplementation to gestating gilts has beneficial effects on average fetal weight, due in part to changes in the IGF system.

Key Words: Carnitine, Gilt, Growth

107 Leukocyte proportions and interferon- Γ concentration in colostrum and milk of lactating sows supplemented with mannan oligosaccharides during gestation and lactation. C. L. Bradley*¹, M. E. Davis¹, D. C. Brown¹, C. V. Maxwell¹, Z. B. Johnson¹, R. Musser², and R. Dvorak³, ¹University of Arkansas, Fayetteville., ²Hubbard Feeds, Inc., Mankato, MN, ³Alltech, Inc., Nicholasville, KY.

Thirty-six gestating sows were randomly assigned to two dietary treatments to determine the effects of mannan oligosaccharide supplementation (MOS) on immune cell populations and interferon- Γ (IFN- Γ) concentration of colostrum and milk. Sows were fed a control (CTL) or MOS-supplemented diet three weeks prior to farrowing and throughout lactation. Colostrum samples were obtained at the onset of farrowing and milk samples were obtained approximately 14 d later. Leukocyte proportions were determined by flow cytometric analysis and IFN- Γ concentrations were measured by ELISA in colostrum and milk fluid. Proportions of TCR Γ Δ +CD8+CD4- cells tended to be greater in colostrum when compared to milk from MOS sows, but was similar in CTL sows (Trt x milk type interaction, P = 0.08). Proportions of CD8-CD4+TCR Γ Δ + cells were greater in milk when compared to colostrum from MOS sows, but was similar in CTL sows (Trt x milk type interaction, P = 0.05). Activated cytotoxic T cells (CD8+CD4-CD25+) were greater in milk when compared to colostrum from CTL sows, but was similar for MOS sows (Trt x milk type interaction, P = 0.05). Proportions of macrophages (SWC1+MHCII-) in milk from MOS sows were greater when compared to colostrum from MOS sows and milk from CTL sows (Trt x milk type interaction, P = 0.08). However, proportions of macrophages were greater (P < 0.001) in colostrum when compared to milk from CTL sows, but was similar in colostrum and milk from MOS supplemented sows (Trt x milk type interaction, P = 0.04). Proportions of antigen presenting cells (MHCII+CD14-) cells in colostrum of CTL sows was greater (P = 0.02) when compared to milk, but was similar in the colostrum and milk from MOS supplemented sows (Trt x milk type interactions, P = 0.02). Interferon- Γ concentration tended to be greater (P < 0.10) in colostrum when compared to milk in MOS supplemented sows. These results indicate that MOS supple-

mentation to sows impacts the immune components of colostrum and milk, which may explain the subsequent improved nursery performance in offspring from sows fed MOS.

Key Words: Mannan oligosaccharide, Sow, Leukocyte

109 Dietary supplementation with zinc oxide increases IGF-I and IGF-I receptor gene expression in the small intestine of weaning piglets. X. Li, J. Yin, D. Li*, X. Chen, J. Zang, and X. Zhou, *National Key Laboratory of Animal Nutrition, Beijing, China.*

The study was conducted to investigate the mechanism for the effect of elevated levels of zinc oxide (ZnO) in enhancing the intestinal growth of weaning piglets. Thirty-six 4-wk-old crossbred barrows were allotted to one of two dietary groups in a randomized complete-block design based on body weight and litter, with 6 pens per group and 3 pigs per pen. One group was fed the basal diet, which contained 100 mg/kg zinc. The other group was fed the basal diet supplemented with ZnO to provide 3000 mg/kg zinc. At the end of the 14-d trial, Pigs were weighed, feed consumption was measured, and blood samples were collected for assays of insulin-like growth factor-I (IGF-I). One pig from each pen was randomly selected to obtain samples of the small intestinal mucosa for the analysis of IGF-I and IGF-I receptor (IGF-IR) gene expression. Small intestinal morphology was also determined. Dietary supplementation with ZnO increased ($P < 0.05$) the average daily body-weight gain, average daily feed intake, and villus height of the small intestinal mucosa (341 μm vs 387 μm ; for 100 and 3000 mg/kg zinc, respectively). The mRNA (0.63 vs 1.02; 0.73 vs 1.33 level relative to that for beta-actin reference gene; for 100 and 3000 mg/kg zinc, respectively) and protein levels for IGF-I and IGF-IR in the small intestine (0.53 vs 1.19; 0.73 vs 1.17 level relative to that for GAPDH reference protein; for 100 and 3000 mg/kg zinc, respectively) were markedly enhanced ($P < 0.05$) by feeding elevated levels of Zn. Serum IGF-I levels did not differ between the control and Zn-supplemental groups. These results suggest that dietary Zn supplementation exerts its beneficial effects on intestinal growth of weaning piglets through increasing expression of the genes for IGF-I and IGF-IR in the small intestinal mucosa.

Key Words: Zinc oxide, Small intestine, Piglets

110 Comparison of water-based and in-feed antimicrobials for growth performance enhancement of weaning pigs. R. O. Gottlob*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, J. L. Nelssen, C. W. Hastad, C. N. Groesbeck, and C. R. Neill, *Kansas State University, Manhattan.*

Two experiments were conducted to evaluate the effects of water-based antimicrobials on growth performance of weaning pigs. In Exp. 1, 350 pigs (initially 5.9 kg and 21 d of age) were allotted to one of five treatments 3 d after weaning: 1) negative control (no antimicrobial in the feed or water); 2) positive control diet containing neomycin sulfate and oxytetracycline (154 ppm neomycin sulfate, 154 ppm oxytetracycline HCl; NEO/OXY); 3) neomycin sulfate in the water (25 mg neomycin sulfate per L); 4) oxytetracycline in the water (25 mg oxytetracycline HCl per L); and 5) combination of treatments 3 and 4. Overall (d 0 to 28), pigs provided water medication had greater ($P < 0.02$) ADG and

ADFI compared to negative control pigs. Pigs fed diets containing NEO/OXY had greater ($P < 0.01$) ADG and ADFI than pigs provided water medication. There were no differences in performance among water medication treatments. In Exp. 2, 360 pigs (initially 6.4 kg and 21 d of age) were allotted to one of eight treatments 3 d after weaning: 1) negative control (no antibiotic in the feed or water); 2) positive control with NEO/OXY in the feed; 3, 4, and 5) neomycin sulfate in the water (38.0, 75.5, and 113.5 mg neomycin sulfate per L, respectively); 6 and 7) neomycin sulfate in the feed (157 and 314 ppm, respectively); and 8) combination of treatments 2 and 4. Overall (d 0 to 24), pigs fed the positive control diet and pigs provided neomycin sulfate in the water or feed had greater ($P < 0.05$) ADG and ADFI compared to negative control pigs. Pigs provided the combination of the positive control diet and medicated water (Treatment 8) had greater ADFI ($P < 0.04$) than pigs provided treatment 2 or 4. Increasing neomycin sulfate in the water or feed linearly increased ($P < 0.04$) ADG and ADFI. There were no differences in growth performance among pigs provided neomycin sulfate in the water or feed. Growth performance was similarly improved by adding neomycin sulfate to either the feed or water.

Key Words: Nursery pig, Antibiotic, Water

111 Effect of intermittent usage of water-based neomycin sulfate on the growth performance of weaning pigs. R. O. Gottlob*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, J. L. Nelssen, C. R. Neill, C. N. Groesbeck, K. R. Brown, and N. Z. Frantz, *Kansas State University, Manhattan.*

A total of 360 weaning pigs (initially 5.2 kg and 18 ± 3 d of age) were used to determine the effects of intermittent use of water-based medication on nursery pig growth performance. Pigs were blocked by initial weight and randomly allotted 3 d after weaning to one of eight treatments: 1) negative control (no antibiotics in the feed or water); 2) positive control diet containing 154 ppm neomycin sulfate and 154 ppm oxytetracycline HCl; 3) and 4) continuous use of 38.0 and 75.5 mg neomycin sulfate per L of water, respectively; 5) and 6) use of 38.0 and 75.5 mg neomycin sulfate per L of water, respectively, during wk 1 and 3 after placement; and 7) and 8) use of 38.0 and 75.5 mg neomycin sulfate per L of water, respectively, during wk 2 and 4 after placement. Overall (d 0 to 28), pigs provided neomycin sulfate in the water continuously (Treatments 3 and 4), and pigs fed the positive control diet had greater ($P < 0.05$) ADG and ADFI compared to pigs provided non-medicated water and feed. There was no difference however, in growth performance and G:F between pigs fed the positive control diet and those provided continuous water-based neomycin sulfate. Numerical increases in ADG and ADFI were observed when pigs were provided water-based neomycin sulfate after drinking non-medicated water as a part of weekly intermittent dosage. However, growth performance returned to the control level immediately after the supply of neomycin sulfate was removed. Pigs provided continuous water medication had greater ADG ($P < 0.02$) and ADFI ($P < 0.04$) than pigs provided an intermittent supply of water-based neomycin sulfate. These data demonstrate that providing neomycin sulfate in the feed or water results in a growth response; however, there is no carryover effect to support intermittent usage of this type of antimicrobial.

Key Words: Nursery pig, Antibiotic, Water

112 Effects of supplementing natural vitamin E in the diets or drinking water of weanling pigs. D. Mahan¹, E. Wilburn*¹, D. Hill², T. Shipp², and H. Yang², ¹The Ohio State University, Columbus, ²ADM, Animal Health and Nutrition, Quincy, IL.

Pigs (n=120; weaning age 18d; BW 5.9 kg) were supplemented with natural (d A-tocopheryl acetate) in the diet or drinking water to evaluate serum responses to this nutrient over a 21 d postweaning (PW) period. The experiment was a 3 x 2 factorial in a RCB design conducted in four replicates. Dietary vitamin E (0, 36, or 220 mg/kg diet), and the addition of vitamin E to the drinking water (0 or 74 mg/L) was tested. Diets formulated to 1.60% and 1.50% lysine (total) were fed from 0 to 7 and 7 to 21 d PW, respectively. The natural vitamin E was mixed with distilled water and added to the drinking water daily, provided free choice and was the only source of water available. Pigs were allotted by weight, sex and litter to treatment pens, bled at 0, 3, 7, 10, 14 and 21 d PW. Water disappearance was measured and averaged weekly. Pigs fed the non-fortified diet and drinking water treatment gained less during the initial 7 d period postweaning and for the overall 21 d period but the response was non significant. Initial serum A-tocopherol averaged 4.08 µg/mL. Pigs on the negative control treatment (diet and drinking water) had a decline (P < 0.01) in serum A-tocopherol at each bleeding period to 0.47 µg/mL at 21 d. In all groups serum A-tocopherol declined to 7 d but then increased by the 21 d period. In general, providing vitamin E in the drinking water showed a higher (P < 0.05) serum concentration of A-tocopherol than supplementing in the diet, with serum A-tocopherol increasing (P < 0.01) as dietary level increased. The combination of supplementing vitamin E in the drinking water and diet resulted in an additive effect on serum concentration of A-tocopherol. Water disappearance increased each week (P < 0.01), but was proportionally higher, relative to feed intake during the initial week PW. These results suggest that providing vitamin E in the drinking water was effective in increasing the vitamin E status of weanling pigs.

Key Words: Pigs, Vitamin E, Water

113 High levels of an *E. coli*-derived phytase can fully replace inorganic phosphorus in grow-finish pig diets. N. Augspurger*¹, J. Spencer¹, D. Webel¹, T. Torrance¹, and B. Wolter², ¹JBS United, Inc., Sheridan, IN, ²The Maschoff's, Inc., Carlyle, IL.

A total of 396 gilts (PIC 337 x C22, 22.4 ± 2.3 kg) were used in a four-treatment trial to investigate the effect of various phytase utilization strategies on growth performance, bone ash, and nutrient excretion of grow-finish pigs. Pigs were housed in an environmentally-controlled building that contained multiple manure pits. Three contiguous pens housing 11 pigs each were located above each pit. Pens were weighed individually and an average weight for each pit was calculated. Blocks of three pits were then formed based on body weight and randomly allotted to dietary treatments, totaling three pits (nine pens) per treatment. Dietary treatments included a phosphorus (P)-adequate corn-SBM control diet, the control diet less 0.13% inorganic P (iP; reduced-P diet), the reduced-P diet + 500 FTU/kg phytase (OptiPhos™, JBS United, Inc.), and a diet devoid of iP with phytase supplemented to meet the P requirements of the pigs. Thus, phytase levels of 1,000, 500, and 300 FTU/kg were supplemented from 22-49 kg, 49-91 kg, and 91-130 kg

body weight, respectively. Phosphorus-releasing values utilized for 300, 500, and 1,000 FTU/kg phytase were 0.10, 0.13, and 0.20%, respectively. Bone ash (3rd and 4th metacarpals; % and mg) was measured on one pig per pen at approximately 74 kg and on three pigs per pen at the end of the trial. Overall, pigs fed the reduced-P diet had lower (P < 0.10) ADG than the other pigs. Additionally, pigs fed the diet devoid of iP with graded phytase supplementation phytase had 3.2% greater (P < 0.10) GF than pigs fed the P-adequate diet. Bone ash (% and mg) was highest (P < 0.05) for control and reduced-P + phytase pigs, while the reduced-P pigs had the lowest (P < 0.05) values, regardless of sampling time. Overall P excretion was reduced (P < 0.01) by 69% in pigs fed the diet devoid of iP with graded phytase utilization. Full replacement of iP with an *E. coli*-derived phytase (OptiPhos™) allowed full expression of growth performance in grow-finish gilts when diets were formulated to a similar calculated available P concentration using accurate P-releasing efficacy estimates for phytase.

Key Words: Phytase, Phosphorus, Pigs

114 Effect of xylanase supplementation on nutrient digestibility of wheat by-products in grower pigs. T. Nortey*^{1,2}, J. Patience¹, J. Sands³, and R. Zijlstra⁴, ¹Prairie Swine Centre Inc., Saskatoon, Saskatchewan, Canada, ²University of Saskatchewan, Saskatoon, Saskatchewan, Canada, ³Danisco Animal Nutrition, Marlborough, Wiltshire, U.K., ⁴University of Alberta, Edmonton, Alberta, Canada.

Wheat by-products can reduce swine feed costs but vary in nutritional value, partly due to arabinoxylans that limit nutrient digestibility. Effects of xylanase supplementation (0 or 4,000 U/kg feed) on GE, P, and Ca digestibility were studied in a wheat control and five 30%-by-product diets (millrun, middlings, shorts, screenings, bran) in a 2x6 factorial arrangement. The control diet was formulated to 3.34 Mcal DE/kg and 2.8 g digestible lysine/Mcal DE, and included 0.4% chromic oxide. Twelve ileal-cannulated pigs (32.5 ± 2.5 kg) were each randomly fed seven of 12 diets at 3 x maintenance in seven 10-d periods, for 7 observations per diet. Digesta and then feces were each collected for 2 d. Wheat had higher ileal and total tract GE digestibility than by-products (P<0.01); xylanase improved both ileal and total tract digestibility for by-products (P<0.001) but not wheat. Among by-products, ileal GE digestibility was lowest for middlings (62%), then bran, screenings, millrun, and highest for shorts (66%). Xylanase improved (P<0.05) ileal GE digestibility of millrun by 19% to 76%. Total tract GE digestibility was lowest for millrun (72%); xylanase improved it to 79% (P<0.05), similar to wheat. Xylanase improved ileal and total tract DE content for all by-products (P<0.01). Total tract P and Ca digestibility was 20 to 38% lower for by-products than wheat (P<0.01). Among by-products, P and Ca digestibilities were lowest (P<0.01) for millrun (32 and 34%); xylanase improved these to 51 and 56%, respectively (P<0.01), similar to wheat. In summary, xylanase improved GE, P, and Ca digestibility and DE content in wheat by-product diets, indicating that arabinoxylans limited by-product nutrient digestibility. To maximize opportunities to include wheat by-products in swine diets, negative effects of by-product arabinoxylans on nutrient digestibility can be alleviated using xylanase supplementation.

Key Words: Wheat by-product, Xylanase, Pig

115 The effect of feed antimicrobial on the prevention and treatment of E coli K88 diarrhoea in young piglets. F. Omogbenigun and E. Beltranena*, *Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada T6H 5T6., Edmonton, AB, Canada.*

A total of 342 Hypor crossbred weanlings (20 ± 1 d) were used in a 35 d trial to evaluate the effects of feed antimicrobial on the prevention and treatment of non-induced, with confirmed naturally-occurring *E. coli* K 88 diarrhoea in a university nursery facility. The dietary treatments were: basal (control) diet containing zinc oxide (3,000 parts per million (ppm) at Phase 1 and 1,000 ppm at Phases 2 and 3); Flavomycin® 4 (12 mg/kg diet bambermycin at Phases 1, 2, and 3); Neo-terramycin® 50/50 (220 mg/kg diet neomycin sulphate, 220 mg/kg diet oxytetracycline hydrochloride at Phases 1, 2, and 3); Tylan® (44 mg/kg diet tylosin phosphate at Phases 1, 2, and 3); increased zinc oxide level (3,000 ppm at Phase 1 and 1,500 ppm at Phases 2 and 3). There were eight pigs per pen and eight pens per treatment. The test diets were offered in three different feeding phases from weaning; a non-medicated common diet was offered during the last week of the trial to avoid conflicting with the administration of the water-soluble ileitis vaccine. Pigs were weighed and scored for symptoms of diarrhoea at the beginning and end of each feeding phase. There was no treatment effect on ADFI, ADG and G:F ($P > 0.05$) for each feeding phase or the overall trial. Pigs fed the medicated diets had better scores ($P < 0.05$) for the lack of incidence of diarrhoea, cleanliness of the anal area, and fewer clinical symptoms of dehydration than those fed the non-medicated, control diet. The use of zinc oxide led to the lowest cost per kg BW gained.

In summary, no benefit in animal performance and merely a slight improvement in physical appearance resulted from antimicrobial inclusion in nursery diets for pigs affected by *E. coli* K 88. The dietary inclusion of zinc oxide was the most cost-effective strategy compared to the tested drug inclusions.

Table 1.

0 - 35d postwean	Control	Flavo	neo-terra	Tylosin	ZnO	SE
ADFI, g	388	393	391	399	419	23
ADG, g	334	342	337	341	365	18
G:F	0.86	0.88	0.87	0.85	0.87	0.02

Key Words: Pigs, Antimicrobials, Performance

116 Growth performance of nursery pigs fed BIOSAF® yeast alone or in combination with in-feed antimicrobial. B. M. Hildabrand*, T. E. Burkey, K. A. Skjolaas, S. S. Dritz, B. J. Johnson, and J. E. Minton, *Kansas State University, Manhattan.*

Previous research with *Saccharomyces cerevisiae* (BIOSAF®) yeast has led to the hypothesis that BIOSAF® may alter the intestinal microbiota in the pig by interacting with or even binding to potential pathogens in the gut. This may be a mechanism by which BIOSAF® could improve the growth rate and overall health of young swine. In the current study, 280 weaned pigs (initial BW 5.66 kg) were used in a 28 d growth study to evaluate the effects of feeding carbadox (CARB), BIOSAF® (0.4%), and the combination of CARB and BIOSAF® (0.15%) in nursery pig diets. Pigs were blocked by sex and BW and

assigned randomly to one of the following four dietary treatments: Control (CTL; no added CARB or BIOSAF®), CARB (CTL diet plus CARB), BIOSAF® (0.4%), or CARB + BIOSAF® (0.15%). There were ten pens per treatment and seven pigs per pen. Treatments were applied in both Phase I (d 0 to 14) and Phase II (d 15 to 28) diets. Overall (d 0 to 28), pigs fed CARB had greater ADG than CTL, and pigs fed the diet supplemented with 0.4% BIOSAF® ($P < 0.03$ and 0.01 vs. CTL and BIOSAF®, respectively). Over this same period, pigs fed the combination diet (CARB + BIOSAF®) had greater ($P < 0.04$) ADG than CTL pigs and pigs fed BIOSAF® alone. In addition, over the 28 d period, pigs fed CARB and CARB + BIOSAF® had greater ($P < 0.05$) ADFI than CTL or BIOSAF® fed pigs. F/G was not affected by treatment. In summary, BIOSAF® alone failed to enhance growth compared to CTL. Also, we did not observe interactions of BIOSAF® with CARB to improve pig growth beyond that of CARB. It is possible that the interactive effects of BIOSAF® reported for other in-feed antibiotics to enhance growth does not include CARB, or perhaps interactive effects are only observed when CARB itself exerts a more potent stimulation of ADG in nursery pigs.

Key Words: Antimicrobials, Yeast, Nursery pigs

117 Growth performance of nursery pigs fed BIOSAF® in combination with in-feed antimicrobials. B. M. Hildabrand*, T. E. Burkey, K. A. Skjolaas, S. S. Dritz, B. J. Johnson, and J. E. Minton, *Kansas State University, Manhattan.*

Results from previous studies indicate that yeast may interact with in-feed antibiotics to stimulate growth performance in nursery pigs to a greater extent than antibiotics alone. However, these effects may be dependent on differences in yeast cultures, processing and yeast activity as well as the specific antimicrobial used. The objective of the current experiment was to evaluate the effects of feeding traditional antimicrobials alone or in combination with *Saccharomyces cerevisiae* (BIOSAF®) yeast in nursery pig diets. In the current study, 240 weaned pigs (initial BW 6.12 kg) were used in a 28 d growth study. Pigs were blocked by sex and BW and assigned randomly to one of the following five dietary treatments: CTL (control diet; no added antimicrobials), NT (CTL diet plus Neo-Terra), DEN (CTL diet plus Denagard PLUS), NT+BIO (CTL diet plus NT and 0.15% BIOSAF®), or DEN+BIO (CTL diet plus DEN and 0.15% BIOSAF®). There were eight pens per treatment and six pigs per pen. Treatments were applied in both Phase I (d 0 to 14) and Phase II (d 15 to 28) diets. Overall (d 0 to 28), pigs fed DEN+BIO had greater ADG than all other treatments ($P < 0.05$) and pigs fed NT, DEN and NT+BIO had greater ($P < 0.05$) ADG than CTL pigs. For the same period, DEN+BIO pigs had greater ($P < 0.05$) ADFI than CTL and NT-fed pigs, but similar ADFI compared to DEN and NT+BIO. In addition, over the entire 28 d experiment, DEN+BIO-fed pigs maintained greater ($P < 0.05$) F/G over CTL and DEN-fed pigs. However, F/G was similar between DEN+ BIO, NT+BIO and NT fed pigs. In summary, BIOSAF® fed in combination with DEN enhanced the growth response of nursery pigs beyond the growth advantage of DEN alone. The interaction of BIOSAF with in-feed antibiotics is generally consistent with other reports. Factors affecting the presence and magnitude of the interaction of BIOSAF® and antibiotics to enhance the growth response remain to be elucidated.

Key Words: Yeast, Antimicrobials, Nursery pigs

118 Application of 2-hydroxy-4-(methylthio)butanoic acid (HMTBa) containing ACTIVATE® nutritional feed acid blends in the nursery pig feeding program of North America. G. F. Yi*, C. D. Knight, C. S. Schasteen, J. Wu, and K. R. Perryman, *Novus International, Inc., St. Charles, MO.*

The objective of current research was to evaluate the effect of patent-pending HMTBa (supplied as ALIMET® feed supplement with 88% L-Met activity) containing ACTIVATE® nutritional feed acid blends on the *in-vitro* antibacterial activity and the *in-vivo* growth promotion effect in weaned pigs. In the *in-vitro* work, a standard corn-SBM diet including ACTIVATE US Starter L (liquid blend 0.45% or 0.6%) or Multimax L (liquid blend 0.45%) was inoculated with *S. typhimurium* or *E. coli*, followed by adding diluted HCl to lower the pH to 4. Samples were incubated for 90 minutes at 37°C, then diluted with distilled water and plated and counted 24 hr later. The results indicated diets including both ACTIVATE liquid blends provided significant antibacterial effects against both *S. typhimurium* ($P < 0.05$) and *E. coli* ($P < 0.05$) compared to control diets with or without antibiotics. Two experiments were conducted at a commercial research facility in Moberly, MO to compare the same two ACTIVATE liquid blends to antibiotics. A total of 528 pigs in Exp. 1 or 440 pigs in Exp. 2 weaned at 17±2 d of age were allotted to one of four dietary treatments in a RCBD (a total 11 pens/trt, 22 pigs/pen, pooled Exp. 1 and 2; 3 phase nursery diet program for 42 d). The positive control diet (Diet 1) contained Mecadox with HMTBa supplemented to satisfy the Met requirement. The negative control (Diet 2) was the same as Diet 1 without Mecadox. Diet 3 and 4 were supplemented with 0.45% ACTIVATE US Starter L or Multimax L liquid blend to provide the Met requirement and to replace Mecadox. Pigs fed Mecadox had significantly improved final BW ($P < 0.02$), ADG ($P < 0.02$), and ADFI ($P < 0.01$) compared to the negative control. Pigs fed ACTIVATE US Starter L and Multimax L showed significant improved final BW compared to the negative control ($P < 0.02$), and had comparable performance to pigs fed Mecadox. The results demonstrated that ACTIVATE is not only a good source of supplemental Met, but can also be an alternative to feed grade antibiotic in nursery pig diets. (®ALIMET and ®ACTIVATE are registered trademarks of Novus International, Inc.)

Key Words: Feed acid, Antibiotic, Pigs

119 Evaluation of 2-hydroxy-4-(methylthio)butanoic acid (HMTBa) containing ACTIVATE® nutritional feed acid blends in different nursery pig feeding programs. G. F. Yi*, S. P. Fiene, R. L. Anderson, C. S. Schasteen, K. R. Perryman, and C. D. Knight, *Novus International, Inc., St. Charles, MO.*

Two experiments were conducted at two commercial research farms in Moberly, MO and Webster City, IA to evaluate the effect of patent pending HMTBa (supplied as ALIMET® or MHA® feed supplement with 88% or 84% L-Met activity) containing ACTIVATE® nutritional feed acid blends on the growth promotion effect in weaned pigs. In Exp. 1, a total of 660 pigs weaned at 17±2 d of age were allotted to one of five dietary trts in a RCBD (6 pens/trt, 22 pigs/pen; 3 phase diets for 43 d). The positive control (Diet 1) contained Mecadox with HMTBa added to satisfy the Met requirement. Diet 2 and 3 was the same as Diet 1 without Mecadox but added with DL-Met or MHA. Diet 4 and 5 were added with 0.3% or 0.5% ACTIVATE DA dry blend to provide the Met requirement and to replace Mecadox. For 43 d, pigs fed Mecadox and 0.5% ACTIVATE DA had improved final BW ($P < 0.08$), ADG ($P < 0.08$), and G:F ($P < 0.10$) compared to pigs fed diet 2 and 3, and there was no difference between two Met sources on an equimolar basis. In Exp. 2, a total of 1,000 pigs weaned at 14±2 d of age were allotted to one of five dietary trts in a RCBD (8 pens/trt, 25 pigs/pen; 4 phase diets for 42 d). The positive control diet (Diet 1) contained Mecadox (d 0 to 7) or CTC (d 7 to 42) with HMTBa added to satisfy the Met requirement. The negative control (Diet 2) was the same as Diet 1 without antibiotic. Diets 3, 4, and 5 were added with 0.4% ACTIVATE DA dry blend (d 0 to 42), 0.5% (d 0 to 14) or 0.35% (d 14 to 42) ACTIVATE DA dry blend, and 0.45% ACTIVATE US Multimax L liquid blend (d 0 to 42), respectively, to provide the Met requirement and to replace antibiotics. During 42 d, pigs fed antibiotics and Diet 4 had improved final BW ($P < 0.05$), ADG ($P < 0.03$), and ADFI ($P < 0.04$) compared to the negative control; and pigs fed Diet 4 had higher G:F versus the negative control ($P < 0.05$). The results demonstrated that ACTIVATE can supply the Met requirement of weaned pigs, and provides growth promoting effects comparable to different antibiotic programs. (®ALIMET, ®MHA, and ®ACTIVATE are registered trademarks of Novus International, Inc.)

Key Words: Feed acid, Antibiotic, Pigs

Odor and Nutrient Management, Swine Extension, Beef Extension Symposium - Understanding Comprehensive Nutrient Manure Planning for Livestock Producers

120 Using CNMPs to meet NPDES permit nutrient management plan requirements. R. Burns*, *Iowa State University, Des Moines.*

Concentrated animal feeding operations that are required to obtain National Pollutant Discharge Elimination System Permits (NPDES) under current federal regulations should consider the option of implementing a Comprehensive Nutrient Management Plan (CNMP). While CAFO regulations are developed by the environmental protection agency (EPA) at the federal level, state water quality agencies will typically implement the regulations at the state level. The NPDES permits for CAFOs require that facilities develop and implement a nutrient management plan. Because the NPDES nutrient management plan requirement is new to many states, it is unclear in some cases what is expected by the state regulatory agencies in a NPDES nutrient management plan. The

EPA has indicated however that correctly prepared CNMPs will meet the NPDES requirement for nutrient management plans. The minimum standards identified by the EPA for NPDES permit nutrient management plans are all items that are included in a complete CNMP, with the exception of chemical handling requirements. There are several reasons producers should consider the development and implementation of a CNMP to meet their NPDES nutrient management plan requirement. One of the foremost is the fact that if the CNMP is developed by a USDA certified Technical Service Provider (TSP), the producer may be able to receive payment from USDA for plan development cost. The ability of a producer to receive these funds depends upon the availability and allocation of these funds by the Natural Resources Conservation Service (NRCS) in the producers state at the time of plan development and implementation. Additionally, CNMPs are required for animal producers to become eligible for USDA-NRCS Environmental Quality In-

centives Program (EQIP) cost-share. For animal producers who are considering applying for Conservation Securities Program (CSP) payments, implementing a CNMP and keeping the appropriate records will provide a solid starting point for the records needed for a successful CSP application. Animal producers can use CNMPs to meet NPDES permit nutrient management plan requirements and can position themselves for USDA incentive programs at the same time.

Key Words: Livestock, Comprehensive Nutrient Management Plan, National Pollutant Discharge Elimination System

121 Software tools for nutrient management planning: Where are we now and where are we headed? B. Joern*, P. Hess, and B. Eisenhauer, *Purdue University, West Lafayette, IN.*

Writing and implementing nutrient management plans (NMPs), whether regulatory or voluntary in nature, is a complicated, calculation intensive process. Planners are required to learn and use several software tools (GIS mapping software, nutrient management software, phosphorus risk assessment spreadsheets, RUSLE2, etc.) that were developed independently with little or no training, and interact with NRCS and state regulatory agencies without a roadmap. Obtaining useful output from nutrient management planning software tools can be a challenge in many states because they have not yet decided on an official format for NMPs. This requires plan developers to spend an inordinate amount of time creating and formatting NMPs that they hope will receive favorable reviews. In the few states that have decided on a NMP format, the usefulness of the NMP to the real end-user (the producer) is limited because most NMP templates currently in use were designed principally to meet government agency reporting requirements. Plan reviewers currently have little recourse in evaluating NMPs other than to manually recalculate planned nutrient applications, risk assessment procedure results, and other data contained in the NMP. This manual verification process is slow, tedious, subject to human error and further increases the cost of implementing NMPs. During this presentation, we will discuss the current state of the nutrient management planning process and provide a vision for a more legible roadmap for this process in the future.

Key Words: Nutrient management planning, Phosphorus indexes

122 Integrating animal feeding strategies into CNMP processes: Role of an updated ASAE standard D384.2. R. K. Koelsch*¹, W. Powers², and A. L. Sutton³, ¹*University of Nebraska, Lincoln*, ²*Iowa State University, Ames*, ³*Purdue University, West Lafayette, IN.*

Feed program decisions impacts manure characteristics and several manure planning processes. The USDA recognizes feed management as one of six key components of a comprehensive nutrient plan.

To better integrate feed management into nutrient planning, a joint animal science and agricultural engineering team produced a new ASAE standard for improving the accuracy of estimating manure excretion. This biologically based approach includes 1) a new excreted manure characteristics summary, 2) equations for estimating, at a minimum, dry matter, N and P characteristics, and 3) as-removed manure characteristics. Species-specific work groups used two different approaches for

their proposed equations. The beef, swine, and poultry groups used an animal mass balance approach where excretion is a difference between intake and retention in body mass or animal products. The dairy and horse groups published equations based upon multi-variable regression analysis of existing data sets. A review of these equations and their estimates of excretion for changes in dietary or performance inputs revealed: 1. Both dietary and animal performance variations cause significant variation in excretion of N, P, and total solids. The equations are capable of responding appropriately under most circumstances. 2. Regression based equations used by the dairy group responded with less change in N and P excretion for similar dietary input changes when compared with other mass balance approaches. For changes in animal performance, the dairy regression equations responded with an opposing trend in excretion when compared to that produced by a mass balance approach. An evaluation of the performance of these equation based estimates reveals some challenges for making situation-specific excretion estimates. ASAE should continue its interaction with the animal science community to encourage additional review and evaluation of these biologically based equations to further validate or improve their accuracy. In addition, an equation based approach for other characteristics such as ammonia-N and other micro-nutrients would add value to the standard.

123 Non-ruminant diet composition effects on land acreage manure application. A. Sutton*, B. Richert, and T. Applegate, *Purdue University, West Lafayette, IN.*

Regulations have forced pork and poultry producers to determine the amount of land required for manure utilization at agronomic fertilization rates based on N or P. Several diet manipulation strategies can reduce the excretion of nutrients, particularly N and P, thereby reducing the environmental impact of swine and poultry manure. Formulating pig and poultry diets on an available P and amino acid (AA) basis can reduce P and N excretion (8-10%). Reducing dietary crude protein and supplementing synthetic AA at specific ratios has reduced N excretion and ammonia emissions (20-50%). Phytase addition to low P diets and use of 25-OH-cholecalciferol in poultry diets has reduced P excretion by 20-30%. Feeding degermed-debranned corn has resulted in P reduction of 19-34%. Additionally, grain varieties (low phytic acid corn and soybean, Nutridense corn, high oil corn) have reduced nutrient excretion substantially. In contrast, by-product feeds such as distillers dried grains and solubles, can increase nutrient excretions, especially P. Reductions in manure P concentrations will bring the N:P ratio closer to meeting agronomic N and P needs of crops and a smaller land base for manure application resulting in 33 to 40% less land need for the manure application. In addition, a higher manure application rate onto cropland will make it feasible to more accurately apply the correct amount of manure to land at a reduction in energy and labor costs. The reduced land base for manure application due diet manipulation can result in an opportunity to expand the operation if there is currently extra land available or use the current land base within government regulations without purchasing additional land or moving manure off-site. Future opportunities for diet manipulation may include genetically modified/selected feeds, feed processing methods, proper by-product utilization, or additives to produce manure with a specific composition to achieve an on-farm nutrient balance. Economic evaluation and incentives are needed to implement diet manipulation by the industry.

Key Words: Nutrient excretion, Phytase, Feed processing

124 Ruminant diet composition effects on land area used for manure application. G. E. Erickson*¹, T. J. Klopfenstein¹, R. K. Koelsch¹, W. F. Kissinger¹, and J. H. Harrison², ¹University of Nebraska, Lincoln, ²Washington State University, Pullman.

Nitrogen (N) and phosphorus (P) management in the diet has a direct impact on amount excreted, which may (P) or may not (N) impact hectares (ha) required for land application. In general, the ratio of N:P in manure results in an over application of P to crop land when manure is applied on a N basis. With feedlot cattle, supplemental mineral P is unnecessary as the requirement is lower than that provided by corn or other conventional ingredients. The challenge with P is managing the conventional feed P and manure resulting from those diets. In commercial, open feedlots, approximately 92% of the P excreted is hauled in manure, but is quite variable due to soil contamination. The cost to distribute P increases by \$0.90 to 2.75/steer when dietary P is increased from 0.29 to 0.49% of diet DM for 2500 to 25,000 head feedlots, respectively, which correlates to 470 to 4700 ha increases for these

feedlot sizes. If accurate spreading costs are determined, informed decisions on use of feeds that are concentrated in P is plausible. Excess dietary N is excreted in urine and will volatilize, therefore, dietary N has little direct effect on manure N or area required. Dietary N does impact volatile losses, which can range from 10 to 90% of N excreted. Other factors impact manure N in open feedlots such as OM on the pen surface, route of excretion, moisture, and temperature. Similar issues are faced by dairy producers. Approximately 30% of the N and 20% of the P consumed by dairy cows is exported off-farm in milk. Feed management opportunities to help achieve whole farm balance include feeding P at recommended levels, balancing diets for RUP and RDP, use of protected amino acids, selection of forage crops, or export of manure nutrients. Diet composition can impact manure amounts, nutrient composition, and subsequent area required for appropriate distribution and nutrient management. In the future, feed management will play an increasingly important role for nutrient management plans required of livestock operations.

Key Words: Feed management, Nutrient management, Ruminants

Ruminant Nutrition - Co-Product and Feedstuff Utilization

126 Optimizing the length of feeding a high distillers dried grains with solubles-soy hull diet to feedlot cattle. J. Homm*¹, L. Berger¹, L. Forster², and T. Nash¹, ¹University of Illinois, Urbana, IL, ²Archer Daniels Midland Company, Decatur, IL.

The rapid expansion of ethanol production has resulted in an abundance of co-products available to cattle feeders. Combining distillers dried grains with solubles (DDGS) and soy hulls (SH) offers several nutritional advantages. Two-hundred forty steers were used to determine the optimum length of feeding a diet containing 40% DDGS and 35% SH (DMB) to feedlot cattle. Treatments consisted of feeding the DDGS-SH diet for 56, 84, 112, 140, and 196 d before being switched to a corn-based finishing diet. All cattle were harvested after 196 d and serial ultrasound measurements were taken every 28 d. Data were analyzed for linear and quadratic effects and orthogonal polynomial contrasts of 56 vs. 196 d were analyzed. Adjusted final weight and ADG increased linearly ($P < 0.01$) and feed efficiency (G:F) decreased linearly as length of time on the DDGS-SH diet increased. Dry matter intake increased linearly as d on the DDGS-SH diet increased. Adjusted final weight tended ($P = 0.09$) to be greater and ADG was greater ($P = 0.01$) for 196 d steers than 56 d steers. However feed efficiency was poorer ($P < 0.01$) for 196 d steers than 56 d steers. Dry matter intakes were greater ($P < 0.01$) for 196 d steers than 56 d steers. Liver scores and hot carcass weights increased linearly ($P = 0.04$) as d on the DDGS-SH diet increased. Carcass marbling score exhibited a quadratic ($P = 0.04$) effect with steers fed 112 d on the DDGS-SH diet having the highest marbling score. At 168 d, there was a linear ($P < 0.05$) increase in backfat with increasing d on the DDGS-SH diet. At 140 and 168 d, 56 d steers had less ($P < 0.05$) backfat than 196 d steers. Ultrasonic marbling exhibited a quadratic ($P < 0.05$) effect at 56, 84, 112, and 168 d, with the 112 d steers having the highest marbling scores. Cost of gain was not significantly different. These data indicate that the use of a DDGS-SH diet can achieve comparable performance and carcass characteristics to cattle fed a typical corn finishing diet.

Key Words: Distillers dried grains with solubles, Soy hulls, Beef

127 Characteristics of fatty acid digestion in finishing diets containing wet distillers grains, a composite, or supplemental corn oil. K. J. Vander Pol*, M. K. Luebbe, G. I. Crawford, G. E. Erickson, and T. J. Klopfenstein, University of Nebraska, Lincoln.

A 5X5 Latin square experimental design evaluated the effects of wet distillers grains plus solubles (WDGS), a composite, or supplemental corn oil addition to finishing diets on duodenal fatty acid profile, DMI and pattern, rumen metabolism, and digestibility. Treatments included a 40% WDGS diet (WDGS), a diet formulated to provide an equal quantity and form of NDF and protein relative to the WDGS diet (BRAN), a diet formulated to provide an equal quantity and form of NDF, protein, and fat relative to the WDGS diet (BRAN+OIL), a high concentrate control diet (CON), and a high concentrate control diet with additional corn oil that provided the same amount of fat as the WDGS diet (CON+OIL). Five ruminally and duodenally fistulated Holstein steers were fed each treatment diet. Periods consisted of 16 d of adaptation and 5 d of collection, collection consisted of rumen samples every 2 hr (d 1), fecal samples 3X daily (d 1-4), duodenal samples every 3 hr (d 4-5), and continuous rumen pH monitoring (d 2-5). DMI was lowest ($P < 0.10$) for the CON+OIL treatment. Ruminant pH was highest ($P < 0.10$) for the BRAN+OIL treatment (5.66) and numerically lowest for the WDGS treatment (5.24). Molar proportion of acetate was lower ($P < 0.10$) and propionate was higher ($P < 0.10$) for the WDGS treatment. The WDGS treatment had greater proportions of unsaturated fatty acids reaching the duodenum relative to the other treatments (Table 1). These data indicate that fat in WDGS may be protected from ruminal biohydrogenation to a greater extent than supplemental unsaturated fat sources, which combined with VFA profiles supports observations for a higher energy value of WDGS relative to corn.

Table 1.

Fatty Acids ^a	WDGS	BRAN	BRAN+OIL	CON	CON+OIL	SE
18:0	48.5 ^e	55.4 ^c	62.6 ^b	56.2 ^{cd}	59.6 ^{bd}	1.4
18:1 <i>trans</i>	12.6 ^b	9.0 ^c	7.2 ^d	5.9 ^d	7.4 ^{cd}	0.7
18:1	9.4 ^b	6.6 ^c	6.0 ^c	7.0 ^c	6.3 ^c	0.4

^a Fatty acids (g/100g) as a proportion of fat reaching the duodenum.
^{b, c, d, e} Means with unlike superscripts differ P<0.10.

Key Words: Finishing cattle, Distillers grains, Fatty acids

128 Addition of wet distillers grains plus solubles in cattle finishing diets containing wet corn gluten feed. P. L. Loza^{*1}, G. E. Erickson¹, K. J. Vander Pol¹, M. A. Greenquist¹, R. A. Stock², and T. J. Klopfenstein¹, ¹University of Nebraska, Lincoln, ²Cargill Wet Milling, Blair, NE.

Crossbred yearling steers (n=504; 376 ± 11.43 kg) were fed for 116 d to determine the effect of adding wet distillers grains (WDGS; Abengoa, York, NE) in diets with a fixed inclusion of wet corn gluten feed (WCGF; Sweet Bran, Cargill, Blair, NE) on steer performance. Steers were blocked (3 blocks) by weight, stratified within block and assigned to 63 pens (8 steers/pen). Pens were assigned randomly to one of seven treatments (9 pens/treatment) consisting of a control diet (CON) with 0% WCGF and six WDGS levels at 0%, 10%, 15%, 20%, 25% and 30% diet DM, in combination with 30% WCGF. Inclusion of 30% WCGF and 0% WDGS significantly improved (P<0.05) ADG, DMI and G:F compared with CON. A quadratic response (P<0.05) was observed for ADG and carcass weight across levels of WDGS with the greatest values for 15 to 20% WDGS added with 30% WCGF. However, no differences were observed with G:F across WDGS levels compared with 30% WCGF alone. Interestingly, feeding 30% WCGF and as much as 30% WDGS resulted in greater ADG and G:F compared with cattle fed CON. These results suggest that the inclusion of WDGS at levels of 15 to 20 % in diets containing WCGF may increase ADG but not G:F.

Table 1. Cattle performance for different levels of WDGS with 30% WCGF

CON	0	10	15	20	25	30	SEM	Quad
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^{a,b} means with different superscripts differ, P<0.02 comparing CON to 30% WCGF, 0% WDGS

Key Words: Cattle feeding, Corn gluten feed, Distillers grains

129 Effects of feeding wet corn distiller's grains with solubles and monensin and tylosin on the prevalence and antibiotic susceptibility of *E. coli* O157 in feedlot cattle. M. Jacob^{*}, J. T. Fox, S. Narayanan, J. S. Drouillard, and T. G. Nagaraja, Kansas State University, Manhattan.

Our objective was to evaluate effects of feeding of wet corn distiller's grains with solubles (WCDGS) in steam-flaked corn based (SFC) diets with and without monensin and tylosin on prevalence and antibiotic susceptibility of *E. coli* O157 in feedlot cattle. Cattle (n=370) were

allotted to 54 pens with 6 to 7 animals/pen and 9 pens/treatment. Treatments were randomly allotted to pens in a 2 x 3 factorial arrangement with factor 1 being 0 or 25% WCDGS and factor 2 being the inclusion of no antibiotics, monensin only (300 mg/d), or monensin (300 mg/d) plus tylosin (90 mg/d). Detection of *E. coli* O157 in fecal samples collected on d 122 and 136 of the study was done by selective enrichment, followed by immunomagnetic bead separation and plating on sorbitol MacConkey agar with cefixime and potassium tellurite. Sorbitol-negative colonies were tested for indole production, latex agglutination for the O157 antigen and API 20E test. *E. coli* O157 isolated from pooled pen samples were tested for susceptibility to 20 antibiotics using a 96-well sensitizer plate. Prevalence of *E. coli* O157 on d 122 was higher (P < 0.01) in pens fed WCDGS compared to those without (25 vs 4%, respectively). This difference was not observed on d 136 (P > 0.50). Feeding monensin or monensin plus tylosin did not affect (P > 0.40) prevalence of *E. coli* O157 on either day. Pooled pen isolates were all resistant to tylosin, tilmicosin, penicillin, clindamycin and erythromycin, and sensitive to trimethoprim/sulphamethoxazole, enrofloxacin, and gentamicin. Eight out of 14 isolates from pens fed WCDGS were resistant to ampicillin, fluorofenicol, oxytetracycline, sulphachloropyridazine, and sulphadimethoxime, but only 3 of 14 isolates from pens not fed WCDGS were resistant to these antibiotics. This study suggests that feeding WCDGS could be a dietary factor affecting prevalence of *E. coli* O157 in feedlot cattle.

130 Effects of high-fat corn condensed distillers' solubles supplementation on ruminal fermentation, digestion, and in situ disappearance in steers consuming low-quality hay. T. Gilbery^{*}, G. Lardy, S. Navarro, M. Bauer, and J. Caton, North Dakota State University, Fargo.

A 4 x 4 Latin square design metabolism experiment was conducted to evaluate the effects of corn condensed distillers' soluble (CCDS) supplementation on intake, ruminal fermentation, site of digestion and forage in situ disappearance rate in beef steers fed low-quality switchgrass hay (*Panicum virgatum* L.). Experimental period length consisted of a 9 d diet adaptation and 5 d of collection. Four ruminally and duodenally cannulated steers (266.7 ± 9.5 kg initial BW) were used in the study. Treatments included: 1) no CCDS; 2) 5% CCDS; 3) 10% CCDS; and 4) 15% CCDS (DM basis). Switchgrass hay (3.3% CP, 42.5% ADF, and 5.9% ash; DM basis) and CCDS (21.6% CP and 17.4% fat; DM basis) were fed as a TMR, using a forage mixer to blend the CCDS with the hay. Ruminal OM digestion increased linearly (P = 0.003) from 40.21 to 50.21% with increasing (0 to 15%) CCDS, while post-ruminal (16.42 ± 3.99%) and total tract OM digestibility (61.71 ± 3.44%) were not affected (P = 0.37) by treatment. Crude protein intake, total tract CP digestibility, and microbial CP synthesis increased (P = 0.06) with CCDS supplementation while microbial efficiency did not change (P = 0.43). Ruminal digestion of ADF and NDF increased (P = 0.02 and 0.008, respectively) with CCDS supplementation. The CP CCDS used in this study was calculated to be 83.5% rumen degradable protein (RDP). Results indicate that CCDS supplementation improves nutrient availability and utilization of low-quality forages.

Key Words: Beef cattle, Corn condensed distillers' soluble, Digestibility

131 Impact of fiber types on rumen buoyancy of corn bran. C. D. Buckner*, T. J. Klopfenstein, G. E. Erickson, J. C. MacDonald, and J. R. Benton, *University of Nebraska, Lincoln*.

A modified in-vitro procedure was used to estimate ruminal buoyancy of byproduct fiber. It is hypothesized that greater buoyancy results in greater retention time and greater ruminal fiber digestibility. Three runs were conducted to evaluate fiber types on corn bran buoyancy in a 4 X 2 Factorial. Strained rumen fluid was obtained from two donor heifers and combined (1:1 ratio), mixed with McDougall's buffer (1:1 ratio), and 150mL was added to 300mL glass tubes and incubated at 39°C for 30h. Each tube contained 6g DM of a feedlot-type diet with 0.45g (7.5%) DM fiber type: alfalfa hay (AL), brome hay (BR), corn stalks (CT), or corn silage (CI). The remaining 5.55g consisted of corn (C) or a 25% corn bran and 75% corn combination (CB/C). Buoyancy of these feedstuffs was evaluated by measuring matte layer disappearance over time with a caliper. Run and time interacted ($P < 0.01$) in buoyancy measurements with a four-way interaction. Treatments containing CB/C had increased ($P < 0.01$) matte layer measurements through 14 hours compared to C and interacted with fiber types. Matte layer measurements converged after 14 hours among all treatments. Treatments with AL had greater ($P < 0.01$) matte layer than other fiber types when paired with C or CB/C. Net matte layer effect was determined by the matte layer difference in CB/C over C for each fiber type minus this difference on treatments with 0% fiber type inclusion. There was a net matte layer effect of bran addition through 30h. AL produced the greatest net effect on bran buoyancy. This technique offers promise as a means of measuring buoyancy of fiber particles.

Key Words: Buoyancy, Corn bran, Fiber

132 Effect of corn density on finishing steer intake, performance, and carcass characteristics. D. Larson, R. Duvall*, M. Bauer, and G. Lardy, *Noth Dakota State University, Fargo*.

A trial was conducted to evaluate the effect of corn density on intake, performance, and carcass characteristics of finishing steers. One-hundred, forty-four crossbred steers were blocked by initial body weight (447 ± 20 kg) and assigned to one of three dietary treatments. Treatments included heavy-test weight corn (69.2 kg/L; 53.7 lb/bushel; HTC), medium-test weight corn (60.4 kg/L; 46.9 lb/bushel; MTC), or light-test weight corn (50.4 kg/L; 39.1 lb/bushel; LTC). Body weight was measured every 28 d, feed intake recorded daily, and feed refusal was recorded weekly. Diet DM was composed of dry-rolled corn (81%), beet pulp (5%), mixed hay (5%), concentrated separator byproduct (5%), and a supplement that provided 27.5 mg/kg monensin and 11 mg/kg tylosin (4%). Calves were implanted with Revalor S on d 0 and slaughtered on d 66 or 82. Data were analyzed with the MIXED model of SAS and mean separation by LSD ($P = 0.05$). There was no effect of treatment on final weight (611 ± 12 kg; $P = 0.77$), or ADG (2.15 ± 0.05 kg; $P = 0.98$). There was a tendency ($P = 0.09$) for calves consuming the LTC diet to have greater DM intake (12.4 ± 0.34 kg) compared to those consuming the HTC diet (11.5 ± 0.29 kg). However, there was no effect of treatment on G:F (0.18 ± 0.01 ; $P = 0.11$). Apparent dietary NEM (2.19 ± 0.05) and NEg (1.51 ± 0.05) were similar ($P = 0.12$) among treatments. At slaughter, HCW (366.7 ± 7.1 kg; $P = 0.77$) and marbling score (407 ± 17 ; $P = 0.20$) did not differ between treatments. Steers fed

LTC tended ($P = 0.09$) to have a smaller LM area (82.2 ± 1.7 cm²) compared to HTC (86.8 ± 1.4 cm²) and MTC (87.0 ± 1.1 cm²) calves. There were no effects of treatment on 12th rib fat (1.14 ± 0.07 cm; $P = 0.52$) or KPH ($1.96 \pm 0.13\%$; $P = 0.29$). Calves fed LTC tended to have greater ($P = 0.08$) yield grades compared to HTC or MTC (3.04, 2.73, and 2.80 ± 0.14 , respectively). We conclude that, although those calves consuming the LTC diet had greater DMI, LTC is a suitable substitute for HTC.

Key Words: Bovine, Corn, Density

133 Effect of corn processing in finishing diets containing wet distillers grains on feedlot performance and carcass characteristics of finishing steers. K. J. Vander Pol*¹, M. A. Greenquist¹, G. E. Erickson¹, T. J. Klopfenstein¹, and T. Robb², ¹*University of Nebraska, Lincoln*, ²*Abengoa Bioenergy, York, NE*.

Three-hundred sixty calf-fed steers (BW = 318 ± 15 kg) were utilized in a completely randomized design to evaluate one of six corn processing methods in finishing diets containing 30% (DM basis) wet distillers grains plus solubles (WDGS). Treatments (i.e. corn processing method) consisted of whole corn (WC), dry-rolled corn (DRC), high-moisture corn (HMC), DRC and HMC combination (1:1 ratio, DM basis; DRC:HMC), steam-flaked corn (SFC), and fine-ground corn (FGC). With the exception of SFC, all corn grain originated from the same hybrid and was grown in similar, irrigated conditions. SFC was obtained from a commercial feedlot at .33 kg/L. Basal dietary ingredients consisted of ground alfalfa hay (5.6% of DM) and dry supplement (3.0% of DM), with the balance being WDGS (30% of DM) and corn (61.4% of DM). Steers were fed for 168 d, and slaughtered on d 169 at a commercial abattoir, with carcass data collection taken after a 48 hr chill. Final BW and ADG were significantly higher ($P < 0.05$) for the DRC treatment relative to FGC, SFC, and WC treatments, but was not different than HMC or DRC:HMC. Gain:feed was greatest ($P < 0.05$) for the HMC treatment relative to FGC, SFC, and WC treatments. No differences were detected between HMC, DRC, or the DRC:HMC treatments for ADG and G:F, with HMC having the numerically greatest G:F. Carcass characteristics reflected degree of finishing in relation to final BW. These data indicate that more intense corn processing methods (FGC, SFC), or no processing (WC) are not as effective as high-moisture or dry-rolled corn in finishing diets containing 30% WDGS.

Table 1.

	FGC	SFC	HMC	HMC	DRC	WC	SE
Final BW ^a , kg	587 ^d	597 ^d	614 ^{bc}	613 ^{bc}	625 ^b	612 ^c	4
DMI, kg/d	9.3 ^d	9.3 ^d	9.5 ^{cd}	9.8 ^c	10.3 ^b	10.5 ^b	0.1
ADG, kg/d	1.53 ^e	1.63 ^d	1.77 ^{bc}	1.78 ^{bc}	1.84 ^b	1.75 ^c	0.03
G:F kg/kg	0.166 ^d	0.176 ^c	0.185 ^b	0.182 ^{bc}	0.179 ^{bc}	0.166 ^d	0.002

^a Calculated from HCW divided by a common dress of 63%. ^{b, c, d, e} Means with unlike superscripts differ $P < 0.05$.

Key Words: Corn processing, Distillers grains, Finishing cattle

135 Influence of corn hybrid on kernel traits and digestibility for cattle. F. W. Harrelson*, G. E. Erickson, T. J. Klopfenstein, L. A. Nelson, and D. S. Jackson, *University of Nebraska, Lincoln*.

Corn hybrids can influence feedlot cattle performance based on kernel characteristics. An experiment was designed using 60 commercially available hybrids, from 22 companies, which were grown for yield testing by Department of Agronomy and Horticulture at Nebraska. Hybrids were grown in 4 plot replicates in one location and sampled at harvest. Samples were analyzed for three separate tests including 1000 kernel weight, Stenvert hardness test, and an *in situ* DM digestibility (iDMD) plus production traits. The iDMD procedure used two ruminally cannulated steers, two incubations for 24 h, and two replications per plot per hybrid (32 total replications per hybrid). Because iDMD mimics ruminal digestion, any relationships between iDMD and physical traits are of primary interest. Averaged across all hybrids, iDMD was $50.5 \pm 1.5\%$ (range 47.5-52.4). Test weight (kg/L) was negatively correlated to iDMD ($r=-0.53$; $P<0.05$) indicating that the more dense or smaller kernels were less digestible *in situ*. This was the only crop production trait correlated with iDMD. The revolutions per minute (RPM) of the Stenvert machine, which indicates hardness based on grinding, was negatively correlated to iDMD ($r=-0.70$; $P<0.05$) indicating that kernels requiring more force to grind are more digestible in the rumen, which is contradictory to previous research. This finding may be related to particle size differences when kernels of varying hardness are ground. Correlation between iDMD and 1000 kernel weight was not significant ($r=0.27$) with an average 1000 kernel weight of 328 ± 23 g (range 273-365). In this study, a 10% change in iDMD was observed between the most and least digestible hybrid; however, the range may have been too small to distinguish relationships to physical traits. This trial indicates that many physical kernel traits may be needed to determine which corn hybrids will be most efficiently used by cattle.

Key Words: Corn hybrid, Digestibility, Feedlot cattle

136 Influence of corn hybrid, kernel traits, and dry rolling or steam flaking on digestibility. F. W. Harrelson*¹, G. E. Erickson¹, T. J. Klopfenstein¹, W. A. Fithian², P. M. Clark³, and D. S. Jackson¹, ¹*University of Nebraska, Lincoln*, ²*Golden Harvest Seeds, Inc., Waterloo, NE*, ³*Kansas State University, Manhattan*.

Processing method for corn can influence digestibility and cattle performance. Recent research has shown that corn hybrid characteristics can also affect digestion and performance. This experiment was designed to test processing method and hybrid across a range of kernel tests shown to correlate with improved feeding value to cattle. Using 72 commercially available Golden Harvest corn hybrids, kernel traits were correlated to *in situ* digestibility. Twelve of these 72 hybrids were selected based on digestibility as dry-rolled corn (DRC), and processed as steam-flaked (SFC) at 0.35 or 0.41 kg/L at Kansas State University to evaluate whether corn processing interacts with hybrid digestibility. Kernel tests included test weight, Stenvert hardness analysis, 1000 kernel weight, and *in situ* DM (DMD) and starch (SD) digestibility. Test weight of dry corn (kg/L) was negatively correlated to DMD for DRC ($r=-0.38$; $P<0.01$). Based on Stenvert test, % hardness of kernels was negatively correlated ($r=-0.27$) but not significantly with DMD for DRC. Across hybrids, a 27% difference in DMD was observed for DRC. A difference in electrical consumption to flake as well as DMD was observed between the two flake densities. The lighter SFC showed a 12% to 30% improvement ($P<0.05$) in DMD compared to the heavy flakes. An interaction was observed ($P<0.05$) between processing method and hybrid for DMD. The hybrid with the softest kernels had the least improvement (6%) whereas one of the harder hybrids was improved 41.5% when flaked versus dry rolled. Hybrid SD increased 8% to 36% for light SFC compared to DRC and a significant interaction was observed between processing and hybrid. The results of this trial suggest that a softer kernel and lighter density flake are more digestible to feedlot cattle, and there can be an interaction between hybrid value and whether fed as dry-rolled or steam-flaked corn.

Key Words: Corn hybrid, Digestibility, Feedlot cattle

Animal Behavior, Housing, and Well Being

137 Effects of distance moved during loading and transport floor space of market weight pigs on transport losses at the packing plant. M. J. Ritter*¹, M. Ellis¹, C. R. Bertelsen¹, R. Bowman², J. Brinkmann², J. M. DeDecker¹, K. K. Keffaber³, C. M. Murphy¹, B. A. Peterson¹, J. M. Schlipf¹, and B. F. Wolter², ¹*University of Illinois, Urbana*, ²*The Maschhoffs, Inc., Carlyle, IL*, ³*ELANCO Animal Health, Greenfield, IN*.

Effects of distance moved during loading and transport floor space on the incidence of transport losses at the plant were evaluated in a study involving 42 loads of pigs (Mean BW = 131.2 ± 0.78 kg). This study used a split-plot design with a 2×6 factorial arrangement of treatments, where loading distances (subplots) were compared within transport floor spaces (main plots). The treatments were: 1) loading distance from the barn exit [short (0 to 30.5 m) vs. long (61.0 to 91.4 m)] and 2) transport floor space (0.396, 0.415, 0.437, 0.462, 0.489, and $0.520 \text{ m}^2/\text{pig}$). Pigs were loaded and unloaded using standard commercial procedures and were transported ~3 h to a commercial plant. The number of non-ambulatory pigs during loading and those experiencing signs of stress (open-mouth breathing, skin discoloration, and muscle tremors) during loading

and unloading, and the number of dead and non-ambulatory pigs at the plant were recorded. Non-ambulatory pigs were classified as fatigued, injured, or injured and fatigued. Pigs moved long compared to short distances during loading had a higher ($P < 0.0001$) incidence of open-mouth breathing during loading (24.9 vs. $11.0 \pm 1.03\%$, respectively), and trends for a higher percentage of non-ambulatory pigs during loading (0.32 vs. $0.08 \pm 0.09\%$, respectively; $P = 0.09$) and for a higher incidence of non-ambulatory injured pigs at the plant (0.24 vs. $0.04 \pm 0.07\%$, respectively; $P = 0.06$). However, loading distance did not affect other losses at the plant. Total losses at the plant were higher ($P < 0.05$) for the three lowest floor spaces compared to the two highest floor spaces (2.84, 1.88, 1.87, 0.98, 0.13, and $0.98 \pm 0.43\%$, respectively for 0.396, 0.415, 0.437, 0.462, 0.489, and $0.520 \text{ m}^2/\text{pig}$). These data confirm our previous findings that floor space during transport has a major impact on losses at the plant.

Key Words: Pig, Transport losses, Transport floor space

138 Sow and litter performance in individual crate and group bedded hoop barn gestation systems. P. J. Lammers* and M. S. Honeyman, *Iowa State University, Ames.*

The effects of gestation system on sow and litter performance over a 2.5 yr. period were evaluated. Gestation housing system treatments were 1) individual gestation crates in a mechanically ventilated, partially slatted floor manure flush confinement building (C); and 2) group pens with individual feed stalls in deep-bedded, naturally ventilated hoop barns (H). In all, 957 litters from 304 sows were analyzed using general linear models. Cull events (120) that occurred during the study were analyzed for correlations between housing treatment and reason for culling. Number born alive per litter was different for the two housing treatments ($P < 0.001$) with H resulting in 0.8 more pigs born per litter. Parity differences were also noted ($P < 0.01$), however there was no interaction between parity and treatment. H sows also weaned 0.4 pigs more per litter ($P < 0.01$). The rate of pre-wean mortality did not differ for the two housing treatments. Cross fostering occurred to approximately equalize litter size within a farrowing room. The effects of parity, farrowing season (quarterly), pig birth weight, and lactation length on pre-wean mortality were significant ($P < 0.01$). There was a trend for C sows to have a 1-day shorter wean-to-conception interval ($P = 0.07$). Farrowing rates for the two treatments were not different. There was an interaction ($P = 0.04$) between breeding season (quarterly) and treatment with H sows bred in summer and C sows bred in autumn having the lowest farrowing rate. There was no correlation between treatment and reason for culling. Failure to conceive was the leading reason for culling in both treatments. There was a trend for sows gestated in C to be culled for feet and leg unsoundness. H sows tended to be culled for poor body condition. Results indicate that gestating sows can be housed in deep-bedded hoop barns equipped with individual feeding stalls and achieve results comparable or superior to gestating sows housed in individual crated gestation systems.

Key Words: Sow and litter performance, Gestation crates, Bedded hoop barns

139 A survey of dairy compost barns in Minnesota. A. Barberg*, M. Endres, and J. Salfer, *University of Minnesota, St. Paul.*

Composting bedded pack barns have raised much interest recently as an alternative dairy housing option. The construction of these facilities in Minnesota has been a producer initiative with the first barn built in 2001. No descriptive data on compost barns were available to date. Therefore, a survey of 13 compost barns was conducted between late June 2005 and September 2005. Producers were interviewed on various aspects related to this housing system, samples of bedding and milk were collected, cow behavior was evaluated, and cows were scored for locomotion, body condition, hygiene and hock lesions. On average, 73.7% of the cows had no hock lesions, 23.1% showed mild lesions (hair loss) and only 3.2% of cows had severe lesions (swollen hocks). The average BCS was 3.04 (± 0.11) with a range of 2.88 to 3.17. On average, only 9.25% of the cows were clinically lame (score of 3 or greater for locomotion). Cow hygiene scores averaged 2.7 (± 0.24) in a scale of 1 to 5 (1=clean; 5=dirty). The average DHIA somatic cell count was 325,000 ($\pm 172,273$) cells/mL. Bulk tank cultures were analyzed on a composite sample of four or five bulk tank pickups. Two out of 13

farms had a high level of *Strep. agalactiae*, one farm was found to have a high level of *Staph. aureus*, six farms had high levels of Non-ag *Strep*, and four farms had high levels of coliforms in the milk. The average lying space per cow was 8.1 (± 2.7) m²/cow with a range of 3.5 to 14.3 m²/cow. Temperatures were taken at each of 12 locations across the pack twice 1 wk apart at various depths (15, 30.5, 61 and 91 cm). The average temperature across depths was 42.3 (± 6.65)°C. The cost of building the barn ranged from \$33,000 to \$300,000. The main reasons for building this type of housing system were for improved cow comfort, cow health and longevity, and ease of completing daily chores. The largest concern was the cost and availability of bedding, especially as additional composting bedded pack barns are built. All of the producers were generally satisfied with their decision to build a compost barn and believe that it was the right choice for housing their dairy herd.

Key Words: Compost barns, Bedded pack, Dairy cows

141 The relationship between inflammatory condition and liver activity in the puerperium and their consequences on fertility in dairy cows. G. Berton¹, E. Trevisi¹, X. Han², and M. Bionaz*¹, ¹*Istituto di Zootecnica, Universita Cattolica del Sacro Cuore, Piacenza, Italy,* ²*University of Saskatchewan, Saskatoon, Canada.*

The relationships between inflammatory indexes, liver functionality immediately after calving, and fertility in dairy cows were investigated. Multiparous dairy cows (n=120) were monitored throughout lactation. Blood samples were collected on 7, 14, and 28 days in milk (DIM). Milk yield was measured weekly until 90 DIM. Disease occurrence during the first 90 DIM and breeding activities were recorded. Forty-three cows were excluded because of culling and serious health problems after 30 DIM. The remaining 77 pregnant cows were retrospectively grouped into quartiles based on a liver activity index (LAI) that included albumin, total cholesterol and vitamin A. Data were analyzed using the mixed model procedure or the frequency procedure of SAS. Cows in the lowest quartile (LO) had a higher ($P < 0.001$) concentration of haptoglobin in plasma measured at 7 DIM than those of the upper quartile (UP) (0.76 vs 0.28 g/L, respectively) indicating a more severe inflammatory condition, as partly confirmed by the higher occurrence of health disorders (32 vs 5 % of cows respectively; $P < 0.04$). Cows in the intermediate lower quartile of LAI (INLO) had the lowest and cows in UP the highest reproductive performance (2.7 vs 1.7 services per pregnancy and 139 vs 93 days open for INLO and UP respectively, $P < 0.05$). Milk yield, however, was similar between these groups (3.31 vs 3.45 ton during the first 90 DIM for INLO and UP, respectively). The LO group did not show a reduced reproductive performance (two services per pregnancy and 110 d open) despite the highest inflammation status, but tended to produce less milk than UP (3.03 vs 3.45 ton during the first 90 DIM). The overall data suggest that cows with higher LAI, having no or only slight inflammatory condition, had higher performance in milk production and reproduction than cows with lower LAI. Our data suggest also that the relationship between reproductive performance and milk yield is not tight, but the presence of inflammatory condition that likewise affect liver functionality, seems to have an important role.

Key Words: Fertility, Liver functionality, Inflammatory condition

Breeding and Genetics - Genetics of Pigs

143 Phenotypic relationships among pig behavior, growth, LM area, and backfat. J. Cassady*, *North Carolina State University, Raleigh.*

The objective of this research was to test the phenotypic relationships among the backtest, resident-intruder test scores (RIS), growth, LM area, and backfat in pigs. Little is known about relationships among measures of pig behavior and economically important traits. However, it may be expected that a pig's behavior affects its performance and the performance of its pen mates. The backtest and resident-intruder test were each done twice on pigs ($n = 145$) from 20 litters. During the backtest a pig was gently restrained in a supine position for 60 s. Number of bouts of struggling by the pig and total time spent struggling were recorded. Cumulative number of escape attempts (BTS) and cumulative time spent struggling (TTS) during both backtests were analyzed. The resident intruder tests, done with 30 to 50 d old pigs, measures the tendency for aggressive behavior toward other pigs. A solid divider was placed down the center of the pen to separate the resident pig from its penmates. An intruder pig of the same sex and smaller size was placed into the pen with the resident pig. When an attack initiated by the resident pig occurred pigs were immediately separated and the test was terminated (RIS = 1). If after 5 minutes no attack occurred, the test was terminated (RIS = 0). The BTS and TTS were correlated ($r = 0.77$; $P < 0.05$) and RIS and BTS were uncorrelated ($r = 0.1$; $P = 0.29$). Dam effects influenced BTS, TTS, and RIS ($P < 0.03$). The BTS and TTS affected ADG in the nursery ($P < 0.04$) and BTS also affected backfat ($P < 0.07$) and LM area ($P < 0.06$). The RIS affected ADG in the nursery, kg of acceptable standardized fat-free lean per day, total kg of acceptable standardized fat-free lean and backfat ($P < 0.05$) and tended to affect days to 110 kg and LM area ($P < 0.1$). Piglets with RIS = 2, showing more aggression, had fewer days to 110 kg, greater lean gain, and more kg of fat-free lean than pigs with RIS = 1 or 0 ($P < 0.05$). Increased BTS and RIS were associated with increased kilograms of lean. In conclusion, phenotypic associations do exist among measures of behavior and performance traits, and increased lean gain was associated with increased aggression.

Key Words: Pigs, Behavior, Growth

144 Estimation of relationships among behavior traits and growth prior to 56 d of age in pigs. B. Velie*, E. Johnson, and J. Cassady, *North Carolina State University, Raleigh.*

The objective of this study was to estimate relationships among five measures of behavior and growth. Greater understanding of relationships among pig behavior and growth are expected to provide opportunities to improve pig welfare. Pigs ($n = 196$) were evaluated using the backtest, resident intruder, human approach (HAT), novel object (NOT), and open door tests (ODT). All tests were done twice with one week between repeated tests. During the backtest a pig was placed in a supine position and gently restrained for 60 sec. Number of bouts of struggling (BTS) was recorded as was total time spent struggling (TTS). The resident intruder test was done in the nursery. A solid divider separated the resident test pig from its penmates. An intruder pig of the same sex and smaller size was placed into the pen. Latency (LAT) was time until

an attack occurred. When an attack occurred pigs were immediately separated (RIS = 1). If 180 s passed with no attack, the test was terminated (RIS = 0, LAT = 180 s). The HAT consisted of a person standing in the pen for a maximum of 5 minutes. Time started when the person was in the center of the pen and all pigs were standing and ended when all pigs made snout contact with the person. A NOT was performed in the same way as the HAT replacing the human with a rubber bucket suspended by a rope. An ODT was done by opening the pen door for a maximum of 5 minutes and recording time for each pig to exit. Performance data consisted of birth weight, weaning weight, 56-day weight, ADG in the farrowing house, and ADG in the nursery. Repeatability of BTS, TTS, RIS, HAT, NOT, and ODT was 0.41, 0.52, 0.21, 0.68, 0.41, and 0, respectively. Phenotypic correlation between HAT and NOT was 0.51. Performance data were analyzed using the GLM procedure of SAS and a model including fixed effects of litter, sex, BTS, TTS, RIS, LAT, HAT, NOT, and ODT. Pigs which spent more time struggling had greater birth weight ($P < 0.01$), ADG in the nursery ($P < 0.06$) and 56-d weight ($P < 0.05$). In conclusion, BTS, TTS, HAT, and NOT were moderately repeatable, but only TTS was associated with growth.

Key Words: Pigs, Behavior, Growth

145 Sex and line differences among feeding behavior traits in pigs. C. Lanier*¹, D. Casey², M. See¹, and J. Cassady¹, ¹*North Carolina State University, Raleigh*, ²*Pig Improvement Company, Franklin, KY.*

Previous studies have shown that differences exist in feeding behavior patterns among purebred lines and between boars and gilts. It is unknown if these differences extend to commercial, crossbred barrows and gilts. The objective of this research was to evaluate sex and line differences among feeding behavior traits during the finishing phase in crossbred, commercial pigs. Feeding behavior traits considered were average daily feed intake (ADFI), average occupation time/day (AOTD), average feed intake/visit (AFIV), average number of visits/day (ANVD), average feeding rate/visit (AFRV), average occupation time/visit (AOTV), and residual average daily feed intake (RADFI). Pigs were penned by sex. Electronic feeders were used to measure the feeding behavior traits on two pens per feeder. Use of the feeder alternated between the two pens weekly. Records were available on crossbred (3 sire lines by 2 dam lines) barrows and gilts ($n = 1564$). Feeding behavior traits were analyzed using the GLM procedure of SAS and a fixed model including sire line, dam line, sex, feeder, switch, and the interactions sire line x dam line, sire line x sex, and dam line x sex. Sex affected ADFI, AOTD, ANVD, AOTV, AFRV, and RADFI ($P < 0.05$). Barrows ate more feed per day, had more visits, spent more time in the feeders, consumed feed at a greater rate, and had higher average daily residual feed intake. Gilts spent more time in the feeders per visit ($P < 0.05$). Sire line affected AFRV, AFIV, AOTV, and RADFI ($P < 0.05$). Dam line affected ADFI, AOTD, ANVD, AOTV, and AFIV ($P < 0.05$). Sire line by sex interaction affected ADFI, AOTD, and ANVD ($P < 0.05$). Sire line by dam line interaction affected AOTD ($P < 0.05$). In conclusion, line and sex differences do exist in commercial, crossbred pigs as they do in purebred boars and gilts.

Key Words: Pigs, Behavior, Feeding patterns

147 Structural correctness and mobility of 1980 vs. 2005 pigs when fed 1980 and 2005 feeding programs. J. Fix*, D. Hanson, E. van Heugten, K. Lovercamp, J. Cassady, and M. See, *North Carolina State University, Raleigh*.

The objective of this study was to assess changes over 25 years in leg structure and mobility. Pigs (n=185) representative of the current commercial industry were compared to commercial pigs from 25 years ago. The 1980 genetic line was produced from dams selected to minimize genetic improvement and frozen semen from boars available in 1980. Pigs within sex, farrowing group, and genetic line were randomly assigned to a feeding program. The 2005 feeding program included phased feeding, pelleted diets, and current diet formulation. The 1980 feeding program consisted of ground diets based on formulations from the 1978 Pork Industry Handbook. Three evaluators scored structural correctness and mobility. Front and rear legs were scored on a 1-5 scale; 1 = excessive set to the joints, 3 = ideal and 5 = extreme straightness in the joints. Front and rear view structure was scored from 1-3; 1 = toes out, 2 = ideal, and 3 = toes in. Mobility scores were 1-5; 1 = severely impaired due to injury, 3 = ideal, and 5 = severely impaired due to structure. A genetic line x sex interaction ($P < 0.01$) was observed where 1980 gilts were straightest in their front leg joints. Pigs from the 2005 genetic line were more relaxed in their front leg joints than the 1980 pigs (3.14 vs. 3.36; $P < 0.01$). A sex x feeding program interaction ($P < 0.01$) was observed where barrows on the 1980 feeding program were more in at the hock than pigs fed the 2005 feeding program. Pigs from the 1980 genetic line had straighter rear leg joints than 2005 genetic line pigs (3.47 vs. 3.31; $P < 0.01$). Base on a genetic line x feeding program interaction ($P < 0.01$) 2005 genetic line pigs on the 1980 feeding program were the most mobile while 1980 genetic line pigs did not differ in mobility between feeding programs. Pigs from the 2005 genetic line were more mobile than 1980 genetic line pigs (3.46 vs. 3.70; $P < 0.01$). Pigs on the 1980 feeding program were more mobile than pigs on the 2005 feeding program (3.54 vs. 3.62; $P < 0.05$). Genetic improvement has occurred in structural correctness and mobility; however, changes in feeding programs have resulted in reduced mobility.

Key Words: Pigs, Genetics, Nutrition

148 Phenotypic evaluation of selection lines for residual feed intake in Yorkshire swine. W. Cai*¹, D. Casey², B. Mote¹, and J. Dekkers¹, ¹*Iowa State University, Ames*, ²*Pig Improvement Company, Franklin, KY*.

Residual Feed Intake (RFI) is a measure of feed efficiency defined as the difference between observed feed intake and that predicted from average requirements for growth and maintenance. The objective of this study was to evaluate response in a selection experiment consisting of a line selected for low RFI (LRFI) and a random control line. Starting with random allocation of purebred Yorkshire littermates, in each generation, electronically measured feed intake, body weight, and ultrasound backfat are evaluated from ~40 to ~115 kg on 90 boars from first parity LRFI sows and 90 gilts from second parity LRFI sows. Following evaluation of first parity boars, ~12 LRFI boars and 70 gilts are selected to produce ~50 litters for the next generation. About 30 control line litters are produced by random mating. Selection is on EBV for RFI from an animal model analysis of average daily feed intake (FI), with group and

sex (fixed), pen within group (random), and covariates for on- and off-test weight and age, for average daily gain (ADG) and change in backfat (BF). After 3 generations of selection, line differences for RFI, FI, ADG and BF were estimated using phenotypic data on 49 LRFI gilts and 38 control gilts that were evaluated for FI from ~40 to ~70 kg for a related research project. Results showed that selection had significantly decreased RFI by 93 g/d and FI by 123 g/d. There were no significant differences in ADG and BF between the lines, although the LRFI line tended to have 22 g/d lower ADG ($P > 0.32$). These results agree well with previously predicted responses from animal model EBV computed using LRFI data only, which were -83, -122, and -17 g/d for RFI, FI, and ADG, especially considering that most selection is on boar data over a test period from ~40 to ~115 kg. In conclusion, RFI is a heritable trait and selection for RFI has significantly decreased the amount of feed required for a given rate of growth and backfat.

Key Words: Pigs, Residual feed intake, Selection

149 Selection for intramuscular fat in Duroc swine: Correlated response in eating quality traits. N. Berry*, C. Schwab, T. Baas, and K. Stalder, *Iowa State University, Ames*.

A study was conducted to evaluate the effects of selection for intramuscular fat (IMF) in purebred Duroc swine on eating quality traits. Littermate pairs of gilts from this population were randomly assigned to either a select line (SL) or control line (CL) and mated to the same boar to establish genetic ties between lines. At least one barrow or gilt was harvested from each litter and carcass data were collected. In the SL, selection in each subsequent generation was based on EBV for IMF with the top 10 boars and top 50% of gilts used to produce the next generation. One boar from each sire family and 50 gilts representing all sire families were randomly selected to maintain the CL. After four generations of selection, a total of 288 CL and 260 SL pigs have been harvested. After evaluation in the packing plant (24 h), a slice of the longissimus muscle from the 11th – 12th rib interface was retrieved and cut into two 2.54 cm thick chops. Chops were delivered to the Iowa State University Food Science Laboratory where they were refrigerated at 0°C for seven d. A trained sensory panel evaluated cooked loin quality attributes. Weights prior to and immediately after cooking were used to calculate percent cooking loss. Three 1.3 cm³ cubes were removed from the center of the 11th rib sample and evaluated by the trained sensory panel for juiciness, tenderness, chewiness, flavor, and off-flavor using an end-anchored, 10-point scoring system. Least squares means for eating quality traits in generations three and four were estimated using PROC MIXED in SAS with a model that included fixed effects of line, generation, harvest group within generation, and sex. Sire and dam within line were random effects in the model. Instron tenderness, pH, percent cooking loss, juiciness, tenderness, chewiness, flavor, and off-flavor scores were not significantly different after four generations of selection for IMF. Genetic and biological mechanisms controlling the deposition of IMF do not appear to be similar to those affecting sensory traits.

Key Words: Intramuscular fat, Selection, Eating quality

150 Genetic change in intramuscular fat: Correlated responses in performance and meat quality traits. C. Schwab*, N. Berry, T. Baas, and K. Stalder, *Iowa State University, Ames.*

A study was conducted to evaluate the efficacy of selection for intramuscular fat (IMF) in purebred Duroc swine. A base population of 56 litters was produced from forty-five gilts that were randomly mated for two generations to boars available in regional boar studs. Littermate pairs of gilts were randomly assigned to either a select line (SL) or control line (CL) and mated to the same boar to establish genetic ties between lines. At an average weight of 110 kg, four longitudinal ultrasound images were collected seven cm off-midline across the 10th-13th ribs of all pigs for prediction of IMF. At least one barrow or gilt was harvested from each litter and carcass data were collected. A slice of the longissimus muscle from the 10th – 11th rib interface was analyzed for carcass IMF. Breeding values for IMF were estimated by fitting a two-trait animal model and the full relationship matrix in MATVEC. In the SL, selection in each subsequent generation was based on EBV for IMF with the top 10 boars and top 50% of gilts used to produce the next generation. One boar from each sire family and 50 gilts representing all sire families were randomly selected to maintain the CL. A total of 288 CL and 260 SL pigs have been harvested. Least squares means for carcass traits were estimated using PROC MIXED in SAS with a model that included fixed effects of line, generation, harvest group within generation, and sex. Sire and dam within line were random effects in the model. After four generations of selection for IMF, the average EBV for select line pigs is 1.03% greater than for control line pigs. Of the pigs harvested, line LS means for tenth rib backfat and loin muscle area were 19.66 mm and 42.80 cm² in the CL, and 21.79 mm and 40.73 cm² in the SL ($P < 0.05$), respectively. Line LS means measured at 24 h for Hunter L and Minolta were 48.05 and 23.47 in the CL, and 49.44 and 24.47 in the SL ($P < 0.05$), respectively. Selection for IMF has resulted in slightly more backfat and less LMA through four generations.

Key Words: Intramuscular fat, Ultrasound, Breeding value

151 Molecular dissection of porcine chromosome 17 QTL for meat quality: From genome scan to sequence information. A. Ramos*¹, Z. Hu¹, S. Humphray², J. Rogers², J. Reecy¹, and M. Rothschild¹, ¹*Iowa State University, Ames,* ²*The Wellcome Trust Sanger Institute, Wellcome Trust Genome Campus, Hinxton, Cambridge, UK.*

The last decade proved fertile for studies that identified numerous QTL for a variety of economically important traits for the swine industry. However, these QTL usually span large distances, which makes their use in pig breeding schemes very difficult, if not impossible. In order to overcome this problem the identification of the underlying mutations responsible for these QTL is necessary. Previously, several meat quality QTL were identified on pig chromosome 17. Fine mapping of the QTL of interest has begun in the relevant region by adding genetic markers and increasing the marker density to the linkage map. As new maps are obtained, new QTL analyses are then performed. An extremely valuable tool to identify the mechanisms responsible for the QTL is the full DNA sequence of the region where specific QTL are located. A highly contiguous, integrated BAC physical map of the porcine genome has been completed by members of the Swine Genome Sequencing Consortium. This resource allows the selection of a minimally overlapping tile path of BAC clones covering the entire genome as well as specific QTL regions. A BAC tile path spanning the meat quality QTL on chromosome 17 has recently been selected and sequenced by the Sanger Institute. The unfinished sequence was then assembled to cover the whole pig QTL region, whose size was estimated to be approximately 6 Mbp. With the high quality finished sequence information becoming available it is now possible to look for polymorphisms, insertions, deletions and gene candidates, which will ultimately lead to the identification of the causative mutation(s) underlying these QTL. The approach and the added value of the sequence can be illustrated with this example of a QTL on chromosome 17.

Key Words: QTL, Pig, Sequence

Ruminant Nutrition - Dairy Cattle Nutrition

152 Does prepartum rumen epithelial development limit early postpartum performance? W. Miller* and J. Shirley, *Kansas State University, Manhattan.*

The rumen epithelium is responsible for absorbing the majority of substrates that supply the daily energy requirements to the dairy cow, regardless of her physiological state. As the physiological status of the dairy cow changes from late lactation/gestating stage to the dry/gestating stage, daily energy requirements are reduced dictating a reduction in diet energy density, which causes the rumen epithelium to undergo an involution period. Rumen papillae become shorter and narrower in response to the reduction in VFA production while maintaining suitable absorptive ability to support the current physiological status. As parturition approaches DMI declines and the normal practice involves increasing the energy density of the diet with the addition of concentrate to offset the decline in energy intake as well as adapt the rumen to an energy dense lactating diet. The response of rumen epithelium to the increase in dietary concentrate levels involves the growth of papillae and subsequently increased surface area which likely enhances absorp-

tion of VFA from the rumen. Improvement in the ability to absorb a greater amount of VFA from the rumen VFA pool would diminish the accumulation of VFA within the rumen and supply a greater amount of substrate to be utilized for gluconeogenesis, suggesting an improvement in energy balance immediately postpartum. Rumen epithelial response to diet modifications was investigated by Dirksen et al. (1985) in that rumen papillae growth was stimulated when cows were switched from a high crude fiber diet to one of lesser crude fiber and increased energy content. Additionally, the ability of the rumen epithelium to absorb VFA from a buffered VFA mixture was much greater after 20 days of receiving a diet with increased energy content (Dirksen et al., 1985). Unfortunately research investigating the absorptive ability of rumen epithelium in vivo has been minimal in the dairy field. Strategies inducing rumen papillae proliferation and/or absorptive capacity during the dry period may stimulate DMI, improve the energy status, and reduce periparturient disorders of the early lactating cow.

Key Words: Rumen, Epithelium, Dairy

153 Propionate regulation of feed intake. B. J. Bradford* and M. S. Allen, *Michigan State University, East Lansing.*

Ruminant diets that include large amounts of readily-fermentable starch are known to limit feed intake. Experiments conducted over the past 20 years have indicated that physiological changes in rumen osmolality, rumen pH, or plasma insulin concentration do not consistently explain hypophagic responses to highly fermentable diets. Meanwhile, evidence has accumulated in a number of species that hepatic oxidation of fuels stimulates satiety. The rapid increase in propionate flux to the liver during meals likely results in oxidation of some propionate under certain conditions, namely, when ruminal propionate production outpaces hepatic conversion of propionate to glucose. We have employed a number of techniques to test the hypothesis that hepatic oxidation of propionate limits feed intake in lactating dairy cattle fed highly fermentable diets. Past work in our laboratory has shown that increased starch fermentability decreases digestible dry matter intake, and that intraruminal infusion of sodium propionate decreases metabolizable energy intake. While these results are consistent with the propionate oxidation hypothesis, our recent work has focused on more carefully elucidating the mechanism through which propionate affects feed intake. Through the use of both pulse-dose and intermediate-term propionate infusions, we ruled out the possibility that propionate acts by stimulating leptin release. We then conducted a set of experiments using the glucose analog phlorizin to increase glucose demand and gluconeogenic capacity. By increasing the potential for glucose production from absorbed propionate, we expected to decrease the proportion of propionate that was oxidized, and in turn, increase feed intake. However, in our initial experiment, phlorizin treatment also increased plasma NEFA concentration, which likely increased hepatic fatty acid oxidation. This probably played a role in the lack of a treatment effect on feed intake, and prevented us from assessing the validity of our hypothesis. We anticipate that ongoing studies using intra-ruminal propionate infusions with and without phlorizin injections will shed more light on the mechanisms behind propionate regulation of feed intake.

Key Words: Feed intake, Propionate, Dairy cattle

154 Milk production of dairy cows fed a wet corn gluten feed during the dry period and lactation. P. Kononoff*¹, S. Ivan⁴, W. Matzke¹, R. Grant³, R. Stock², and T. Klopfenstein¹, ¹University of Nebraska, Lincoln, ²Cargill, Inc., Blair, NE, ³Miner Institute, Chazy, NY, ⁴University of Maryland, College Park.

Thirty-six primiparous and forty multiparous Holstein cows were used in an experiment to examine the effects of feeding wet corn gluten feed (WCGF) on 305-d milk production, dry matter intake (DMI), body condition score (BCS). The experimental treatments were ; 1) control; WCGF not fed (n=27), 2) WCGF-L; cows received diets containing WCGF (38% DM basis) during lactation (n=23), 3) WCGF-DL; cows received diets containing WCGF (38% DM basis) during the dry period and lactation (n=26). During the dry period cows consuming WCGF were observed to have a significant ($P < 0.05$) gain in BCS (0.07) compared to a loss in BCS in cows fed the control diet (Control = -0.11 and WCGF-L = -0.04). During lactation there were no differences ($P > 0.05$) due to treatment on BCS. Cows consuming WCGF during lactation consumed more ($P < 0.05$) feed compared to the control: 25.4, 23.8, 21.2 kg per day for WCGF-L, WCGF-DL and control, respectively.

Milk production was higher ($P < 0.05$) for cows consuming the WCGF: 35.0, 34.7, 31.1 kg per day for WCGF-L, WCGF-DL, and control, respectively. No differences ($P > 0.05$) were observed in either DMI or actual milk yield between WCGF-L and WCGF-DL treatments indicating that prepartum diets did not influence lactational performance. The WCGF resulted in a significant ($P < 0.05$) reduction on the concentration of milk fat (3.94, 3.74, 4.15% for WCGF-L, WCGF-DL, and control respectively), but because total milk yield was increased, no differences ($P > 0.05$) were observed in total milk fat yield. In addition, 3.5% FCM tended ($P = 0.10$) to be affected by diet: 38.9, 36.3, 34.7 kg per day for WCGF-L, WCGF-DL, and control respectively. The increasing effect of DMI and accompanying milk yield resulted in a similar efficiency of 3.5% FCM milk production for all treatments, averaging $1.5 + 0.09$. Total protein yield was significantly ($P < 0.05$) higher for cows consuming WCGF during lactation; 1.15, 1.10, 1.00 kg per day for WCGF-L, WCGF-DL, and control respectively. These results indicate that the intake response in cows consuming WCGF during lactation resulted in a greater supply of energy and higher level of milk production.

Key Words: Lactation, Wet corn gluten feed

155 Lactational performance of dairy cows fed wet corn distillers grains for the entire lactation. G. S. Mpapho*, A. R. Hippen, K. F. Kalscheur, and D. J. Schingoethe, *South Dakota State University, Brookings.*

The lactation performance of dairy cows fed distillers grains for a complete lactation was evaluated using 18 multiparous Brown Swiss cows, 14 primiparous Holstein and 16 multiparous Holstein cows randomly allocated to two dietary treatments in a completely randomized design. Cows were blocked by parity, breed, and expected calving date. The early lactation experimental diets contained 35% corn silage and 15% alfalfa hay (DM basis) and was fed from 22 to 105 DIM while the mid-lactation experimental diets contained 35% corn silage and 20% alfalfa hay (DM basis) and was fed from 106 DIM to dry-off date. The treatment diet consisted of wet corn distillers grain (WDG) fed at 15% of DM for the entire lactation replacing corn grain, soybean meal, extruded soybeans and expeller soybean meal in the control diet (C). Early lactation diets were balanced at 17% CP (DM basis) and 1.63 Mcal NEL/kg whereas mid-lactation diets were balanced to provide 16% CP and 1.78 Mcal NEL/kg. Dry matter intake of cows fed WDG and C (21.8 vs 23.2 kg/d) did not differ between treatments. There was no difference in average daily milk production (33.6 vs 31.7 kg/d; $P > 0.32$) and 4% FCM (33.9 vs 30.5 kg/d; $P < 0.09$). However, feed efficiency (FCM/DMI) was significantly affected by treatments (1.57 vs 1.30; $P < 0.03$). Fat percent (4.07 vs 3.75; $P < 0.02$), fat yield (1.38 vs 1.20 kg/d; $P < 0.05$), protein percent (3.22 vs 3.05; $P < 0.01$) and protein yield (1.07 vs 0.96 kg/d; $P < 0.04$) were greater for cows on WDG diet. Cows fed WDG had greater body weight gain (43.9 vs 34.6 kg; $P < 0.03$) and body condition (3.41 vs 3.29; $P < 0.03$) at the end of lactation than those fed C. There was no difference in days open (190 and 182 days; $P > 0.78$) and lactation length (355 vs 343 DIM; $P > 0.35$). Relative to the control, feeding of WDG at 15% of diet DM for the entire lactation increased milk component percentage and yields, feed efficiency, body condition and body weight gain while maintaining milk yield and feed intake.

Key Words: Distillers grains, Dairy cows, Milk production

156 Influence of plane of nutrition on growth of dairy calves.

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Our objective was to determine effects of plane of nutrition on growth of Holstein calves from birth to 20 wk of age. Calves (31 female, 44 male) were assigned at 3 d of age to 3 treatments (n=25) in a randomized block design: 1) conventional milk replacer (20% CP, 20% fat) and starter (20.4% CP, DM basis), 2) moderate enhanced milk replacer (28% CP, 17% fat) and starter (23.3% CP, DM basis), and 3) aggressive enhanced milk replacer (28% CP, 20% fat) and starter (25.8% CP, DM basis). For treatment 1, milk replacer (11% solids) was fed at 3 kg/d during wk 1, 4 kg/d from wk 2 to 5, and 2 kg/d during wk 6. For treatment 2, calves were fed 4.2 kg milk replacer (13 % solids) for 2 d. From d 5 to wk 5, milk replacer (14% solids) was fed at 6.4 kg/d. During wk 6, 3.2 kg/d of milk replacer was fed. For treatment 3, calves were fed 4.5 kg milk replacer (18% solids) during wk 1. From wk 2 to 5, calves received 6.2 kg/d, and during wk 6, 3.1 kg/d of milk replacer was fed. For all treatments, starter was available for ad libitum intake from d 3. From wk 13-20, all calves were fed conventional starter (20.4% CP). Before weaning (wk 6), average daily gain (ADG) of BW (0.42, 0.55, and 0.62 kg/d) was greater for treatments 2 and 3 than treatment 1 (P<0.01) and greater for treatment 3 than 2 (P=0.05). Gain to feed ratio (0.39, 0.60, 0.62) to weaning was greater for calves fed treatments 2 or 3 (P<0.01). From wk 7-12, ADG of BW (0.98, 1.07, 0.82 kg/d) was lower for calves previously fed treatment 3 than treatment 2 (P<0.01). BW at 12 wk (105, 113, and 106 kg) and 20 wk (185, 190, and 180 kg) was greater for calves previously fed treatment 2 than for those fed treatment 3 (P<0.01). Withers height at 12 wk (94.1, 95.0, and 93.6 cm) and 20 wk (106.2, 107.3, and 105.6 cm) followed the same pattern (P<0.05). Cost of BW gain was 1.19, 1.45, and 1.79 \$/kg. The moderate milk replacer feeding program improved the transition at weaning for dairy calves in an enhanced early nutrition program.

Key Words: Calves, Growth, Milk replacer

157 Effect of supplementing a medicated intensive milk replacer and calf starter with Apex.

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The objective of this study was to evaluate the effects of APEX on growth and performance of calves when added to an intensive feeding program. Holstein bull calves (n=60 for experiment, n=20 per treatment), less than 7 d of age were purchased from an area sale barn. Calves were assigned by weight to a control treatment (CON) of a 25% protein, 15% fat milk replacer plus an 18% crude protein calf starter, a milk replacer treatment (MR) of a 25% protein, 15% fat milk replacer with APEX 3035 plus an 18% crude protein calf starter, or a milk replacer and calf starter treatment (MR/CS) of a 25% protein, 15% fat milk replacer with APEX 3035 plus an 18% crude protein calf starter with APEX 3030. Milk replacer was medicated with Neomycin Base-Oxytetracycline was fed at a rate of 1.5 lb (681g) per day for 42 days. Calf starter was texturized and medicated with Decoquinatone and was offered from d 1 in increasing levels with increasing intake. Calves were housed in individual hutches with water available free choice from d 0. Feed intake, fecal scores and health treatments were recorded daily. Calves were weighed weekly. Calves were weaned on d 42 dependent on a minimum intake of 454 g of calf starter for 3 consecutive d. Calves fed MR increased (P<0.02) starter intake during the trial compared to calves fed CON and MR/CS. The MR treatment increased starter intake 28.0 and 18.5% over CON and MR/CS treatments, respectively. Final body weight was highest for the MR treatment, lowest for CON and intermediate for MR/CS treatments (P<0.04). Average daily gain for the MR treatment (P<0.02) was 0.3 and 0.2 lb per day greater than CON and MR/CS treatments, respectively. Calves fed MR had the fewest treatment days with the MR/CS treatment highest and the CON treatment intermediate (P<0.05). Addition of APEX to milk replacer fed in an intensive feeding program resulted in increased starter intake and growth. Inclusion of additional APEX in the starter feed had a negative impact on intake and performance.

Key Words: Calf, Apex, Intensive feeding

Breeding and Genetics - Genetics of Longevity in Food Animals

160 Evaluation, interpretation and relevance of stayability in beef cattle genetic improvement. D. Garrick*, Colorado State University, Fort Collins.

Profitability of a cow-calf system is influenced by herd age structure. Mixed-age cows are typically more productive than either primiparous or aged females. Herds with short productive lives require more replacements, have more calving difficulty, greater replacement costs, and produce fewer sale offspring with lighter weights, than those with long lives. Age structure is reflected in stayability, a measure of whether or not an animal remained in the herd until a specified point in time. Stayability EPDs based on survival to age six are available for Red Angus (RA), Limousin and Simmental bulls. In average RA herds, the highest stayability bulls have about 60% and the worst bulls about 40% daughters remaining after five calving opportunities. Improved stayability can result from genetic progress in bull-breeding herds. Genetic trends in RA indicate 10% improvement in stayability over 40 years. Stayability is partly a characteristic of the animal manager unless voluntary culling

is non-existent. For example, in an effort to increase the frequency of black coat color alleles in Simmentals, sires carrying red factor alleles had reduced apparent stayability unrelated to productive or reproductive characteristics. Stayability EPDs are derived using a single trait threshold model, ignoring variation in disappearance rate prior to, or after, age six. Threshold analyses derive EPDs on an underlying scale that is problematic to interpret because the impact of a unit change varies according to average phenotypic stayability. More accurate evaluations could be achieved using a multiple trait approach accounting for stayability at each age as separate correlated traits. Total herd reporting (THR) where the fate of every animal is recorded is helpful but yet to be adopted by all Breed Associations and can be problematic as culled cows may have multiple reasons for being culled. Derivation of functional stayability, adjusted for voluntary culling reasons, requires THR. Economic consequences of altering stayability depend upon average stayability, average calving ease of first-calf heifers, weanling sale prices, replacement feed costs and salvage values of cull animals.

Key Words: Stayability

161 Genetically improving the productive lives of dairy cows: It can be done faster than most people think is possible. L. B. Hansen*, *University of Minnesota, St. Paul.*

Dairy producers often comment that cows have less longevity today than in the past. To some extent this is true, but in recent years, little evidence exists to suggest that the average length of life is decreasing among cows that are slaughtered. However, more cows are dying on farms than in the past, and this is decreasing the average lifespan of dairy cows. What has changed, especially in recent years, is dairy cows are calving fewer times during their lifetimes. Dairy producers can select for longevity of cows by using the genetic trait called Productive Life, which credits cows for only the first 10 mo of lactation and doesn't reward cows for long lactations or dry periods. In the past, milk production was the best predictor of Productive Life, but that is no longer the case. At this time, fertility of cows (expressed via the genetic trait called Daughter Pregnancy Rate) has the largest genetic relationship (correlation of about +0.50) with Productive Life. Also, health problems play a major role in determining the longevity of cows. The genetic contribution to Productive Life, Daughter Pregnancy Rate, and all measures of health is small compared to other contributions (nutrition and management). Of course, this definition of genetic contribution is measured on a within-breed basis (effects of individual alleles — genes). New research has documented the powerful influence of interaction of alleles to impact traits such as fertility, health, and longevity of dairy cows. For fertility, genetic control (heritability) within breed is about 3%. However, the power of heterosis (hybrid vigor), which involves the interaction of alleles, brings genetic control of these traits to levels in the range of 15% or more. Crossbreeding has been documented in pigs, beef cattle, and sheep to have greatest and substantial impact on traits related directly to fertility and health and indirectly to longevity. Dairy produc-

ers have ignored the gift of heterosis for fertility, health, and longevity through much of modern history, and that situation appears to be changing.

Key Words: Longevity, Genetics, Heterosis

162 Longevity in pigs: Perspectives on genetics and production. S. Newman*, *Sygen International, Franklin, KY.*

Longevity in pigs is of economic importance because (1) the higher the number of litters produced by a sow, the greater the opportunity to spread sow costs over a longer period of time, therefore increasing profitability; and (2) increased longevity tends to extend the parity distribution at the expense of lower parities, increasing pigs per sow per year through increased litter size and reduced rebreeding interval. This review will focus on definitions of longevity and their interpretation in terms of both economic and genetic modeling. There is a limited amount of information available pertaining to the genetics of longevity in pigs per se in terms of genetic parameter estimates. However, sow longevity can be addressed in pig breeding programs through the proper definition of breeding objectives, and correlated selection criteria that are heritable and easy to measure. This requires the estimation of an economic value for longevity. This allows for incorporation of longevity into genetic evaluation schemes for the production of estimated breeding values.

Key Words: Longevity, Pigs, Breeding objectives

Growth and Development, Muscle Biology, and Meat Science - Practical Aspects of Meat Quality

163 Impact of growth promotants on beef and pork quality. F. K. McKeith*, S. F. Holmer, and J. Killefer, *University of Illinois, Urbana.*

Efficient production of a high quality meat product has been the focus of the industry for over the past 50 years. Through the use of growth promoting compounds, efficiency of production has been significantly improved. However, as the industry has become more quality conscious, the impact of these growth promoting compounds on meat quality has become an issue in some segments of the beef and pork markets. Growth promoting compounds may be generically classified as anabolic steroids (e.g. androgenic and estrogenic), protein hormones (e.g. growth hormone) and beta-adrenergic agonist (e.g. clenbuterol, zilpaterol, or ractopamine). These compounds, while acting through various cellular mechanisms, alter animal metabolism so that feed is better utilized and results in increased lean tissue growth. Because the various growth promotants act through distinct mechanistic pathways and may have differing species responses, their effect on both growth efficiency and product quality may vary. Livestock production in the United States has seen the approval of the beta-adrenergic agonist (i.e. ractopamine) as a typical growth promotant used in swine. While in beef cattle, the use of beta-adrenergic agonist and steroid products (androgenic, estrogenic, or combinations of the two) are commonly used.

Quality may be characterized differently by the various segments of the production chain, yet the ultimate impact on the variables that consumers use to evaluate fresh meat, must be taken into consideration. The focus of this discussion will be to evaluate the influence of growth promotants on meat quality, specifically the visual aspects (color, marbling, purge, and firmness/texture) that lead to the intent to purchase and the impact of these different growth promoting compounds on palatability attributes.

Key Words: Growth promotants, Meat quality

164 Effects of feeding duration on growth performance and carcass characteristics of feedlot steers. M. Greenquist*¹, K. Vander Pol¹, G. Erickson¹, T. Klopfenstein¹, and M. Van Koeveing², ¹*University of Nebraska, Lincoln*, ²*Elanco Animal Health, Greenfield, IN.*

Crossbred, feedlot steer calves were used in a RCBD to evaluate the effects of Ractopamine HCL (RAC) on growth performance and car-

cass characteristics when fed for 28 or 42 d prior to slaughter. Within block, cattle were weighed for two consecutive days and randomly assigned to treatment pens at re-implanting (82 d). The treatment phase consisted of 0 or 200 mg/hd/d of RAC fed for 28 or 42 d prior to slaughter (DUR). All steers were projected to be fed and slaughtered at 179 d, therefore steers fed for 42 d were fed RAC an additional 14 d and slaughtered at 193 d. Steers were weighed individually at 0 d, 28 d and 42 d, and pen weighed weekly (0, 7, 14, 21, 28, 35 and 42 d) to determine growth performance profile. Analyses of growth performance data were conducted using a mixed model procedure with pen as the experimental unit. The statistical model included treatment (RAC dose and RAC DUR) as the independent fixed effect, and block as a random effect. Initial body weight was used as a covariate. There were no RAC dose x RAC DUR interactions ($P > .44$). The main effect of DUR will be discussed. Increasing DUR by 14 d increased final BW by 3.8% (590.5 vs. 612.9 kg, $P < 0.01$), while ADG numerically decreased by 4.4% (1.83 vs. 1.75 kg/d, $P = 0.07$). Steers fed 14 d beyond their projected finishing date increased DMI 3.1% (10.56 vs. 10.89 kg, $P = 0.02$) resulting in a reduction in weight gain efficiency of 7.0% (G:F 0.171 vs. 0.159, $P < 0.01$). Increasing DUR by 14 d resulted in greater HCW by 4.2% (377.1 vs. 393.1 kg, $P < 0.01$), dressing percent (63.90 vs. 64.20, $P < 0.05$), REA, KPH and 12th rib fat thickness ($P < 0.01$). Increasing DUR by 14 d did not result in greater marbling scores (514 vs. 519, $P = 0.54$). Feeding steers past their projected finishing date can lead to increased weight gain and fat deposition; however the efficiency and value of the weight gain must be closely monitored.

Key Words: Duration, Steer, Growth

165 Effects of feeding a beta-agonist on longissimus muscle fiber area and diameter, and fiber associated nuclei in cull beef cows. J. Gonzalez*, J. Carter, D. Johnson, and S. Johnson, *University of Florida, Gainesville*.

Culled crossbred beef cows ($n = 92$; 11 yr \pm 1.8) were fed a basal diet plus a beta-agonist (BETA; ractopamine) to evaluate the effects on longissimus muscle (LM) fiber area and diameter, and fiber associated nuclei. Cows were fed in a 2x2 completely randomized block design with dietary treatment and implant status (trenbolone acetate plus estradiol) as factors. One-half of all cows were fed the basal diet (CON) for 90d; the remainder received CON for the first 55d, then were fed CON plus BETA (200 mg•hd⁻¹•d⁻¹) for the last 35d. Carcasses were harvested on d 92 and 24h postmortem LM samples were frozen and stored in OCT at -80°C . Twelve micrometer cryosections were immunostained for dystrophin. Nuclei were detected by propidium iodide histology. Representative images were captured and fiber diameter, area, and associated nuclei were measured (Lucia 5.1). For both measured area and diameter, there was a significant treatment by implant interaction ($P = 0.0004$). Fiber nuclei data indicated that there was a significant treatment by implant interaction ($P < 0.0001$). Contrasts of LSMEANS revealed that animals implanted and fed BETA had increased ($P < 0.05$) muscle fiber area and diameter compared with CON fed animals with and without implants, and BETA fed animals without implants. Contrasts of LSMEANS for associated nuclei showed that the BETA fed animals with implants had significantly fewer associated nuclei than the CON fed animals with implants and BETA fed animals without implants ($P < 0.05$). Therefore, feeding BETA in addition to an implant had a positive effect on LM diameter and area through a mechanism independent of increased myonuclear number.

Key Words: Cows, Muscle fiber, Beta-agonist

166 Effect of Optaflexx dosage and duration of feeding prior to slaughter on growth performance and carcass characteristics. G. I. Crawford*¹, G. E. Erickson¹, K. J. Vander Pol¹, M. A. Greenquist¹, J. D. Folmer¹, and M. T. Van Koeveering², ¹*University of Nebraska, Lincoln*, ²*Elanco Animal Health, Omaha, NE*.

Eight hundred fifty-five English x Continental steers (529 \pm 17 kg) were used to determine the effect of Optaflexx dosage and duration of feeding on performance and carcass characteristics. At re-implant, steers were assigned to 36 pens in the heavy block (10 steers/pen) and 45 pens in the light block (11 steers/pen) and treatments were assigned randomly to pen. Treatments were arranged in a 3 x 3 factorial design with factors including Optaflexx feeding duration (final 28, 35, or 42 d of the feeding period) and Optaflexx dosage (0, 100, or 200 mg/hd/d). All diets contained 55.4% high-moisture corn, 30% wet corn gluten feed, 7.5% alfalfa hay, 4% supplement and 3.1% Optaflexx 45 premix with fine-ground corn as carrier. No dose x duration interaction was observed ($P > 0.58$) for any performance variable. Duration of Optaflexx feeding did not impact ($P > 0.38$) DMI, G:F, ADG, or carcass characteristics. Feeding Optaflexx at increasing dosage slightly decreased DMI linearly ($P = 0.01$) from 10.9 kg/d for the control and 100 mg Optaflexx/hd/d treatment groups to 10.7 kg/d for cattle fed 200 mg Optaflexx/hd/d. Average daily gain linearly increased ($P < 0.01$) with Optaflexx dosage from 1.84 kg/d to 1.88 and 1.96 kg/d when cattle were fed 0, 100, and 200 mg Optaflexx/hd/d, respectively. This contributed to a linear improvement in gain:feed ($P < 0.01$), measuring 0.166, 0.171, and 0.181 kg ADG/kg DMI for steers fed 0, 100, and 200 mg Optaflexx/hd/d, respectively. Final live weight and carcass weight increased linearly with Optaflexx dosage ($P < 0.01$), resulting in increases of 1.3 and 3.6 kg of live weight and 2.7 and 3.6 kg of carcass weight compared with the control when 100 and 200 g of Optaflexx/hd/d, respectively, was fed. Results indicate that feeding Optaflexx at 100 or 200 mg/hd/d for the final 28 to 42 d appears beneficial when compared with feeding diets without Optaflexx.

Key Words: B-agonist, Feedlot cattle, Feed efficiency

167 Effects of Optaflexx fed in combination with melengestrol acetate on feedlot performance of heifers. W. A. Griffin*¹, G. E. Erickson¹, B. D. Dicke², R. J. Cooper², D. J. Jordan², J. S. Drouillard³, W. M. Moseley⁴, D. J. Weigel⁴, and G. E. Sides⁴, ¹*University of Nebraska, Lincoln*, ²*Cattlemens's Nutrition Services LLC, Lincoln, NE*, ³*Kansas State University, Manhattan*, ⁴*Pfizer Animal Health, New York, NY*.

A commercial feedlot experiment was conducted to determine the effects of feeding Melengestrol Acetate (MGA) alone or MGA plus 200 mg/hd of ractopamine (Optaflexx; MGA+OPT) on performance and carcass characteristics of finishing heifers. MGA (0.4 mg/h/d) was fed the entire feeding period. Heifers ($n = 1807$; 338.8 \pm 37.1 kg) were assigned randomly based on arrival group to one of 20 pens (10 pens/trt) and fed for an average of 133 d. Heifers were initially implanted with Ralgro and reimplanted 80 d prior to slaughter with Synovex Plus. Final live BW was not different ($P = 0.34$), however, heifers receiving MGA+OPT were 7.0 kg heavier compared to heifers fed MGA. Heifers receiving MGA+OPT had 3.3 kg heavier HCW ($P = 0.02$) compared to heifers receiving MGA. HCW was used to evaluate performance in order to minimize variation in gut fill. When evaluating performance over the entire feeding period on a carcass adjusted basis (HCW /0.635), ADG increased 0.06 kg ($P = 0.01$) for heifers receiving MGA+OPT

relative to heifers receiving MGA alone. DMI was higher for heifers receiving MGA+OPT (10.8 vs. 10.6 kg; $P=0.01$) and G:F was improved 1.7% ($P=0.04$) compared to heifers receiving MGA alone. When evaluating performance the last 35 d of the finishing period (time when heifers were receiving Optaflexx) on a carcass adjusted basis, heifers receiving MGA+OPT had increased DMI (10.7 vs. 10.4 kg; $P=0.02$), a 7.9% improvement in G:F ($P=0.02$), and ADG was increased 0.14 kg ($P=0.01$) compared to heifers fed MGA alone. Carcass characteristics including quality grade, 12th rib fat thickness, yield grade, LM area, and KPH were not different ($P>0.24$). In this study, feeding Optaflexx in combination with MGA to finishing feedlot heifers increased HCW, improved G:F, and increased ADG without affecting carcass quality.

Key Words: Ractopamine, Melengestrol acetate, Heifers

168 Evaluation of Synovex Choice/Synovex Choice versus Revalor-IS/Revalor-S implant strategies in beef finishing steers.

P. L. Loza*¹, G. E. Erickson¹, C. G. Campbell³, B. D. Dicke⁴, R. J. Cooper⁴, D. J. Jordon⁴, J. S. Drouillard², and T. J. Klopfenstein³, ¹University of Nebraska, Lincoln, ²Kansas State University, Manhattan, ³Ford Dodge Animal Health, Overland Park, KS, ⁴Cattlemen Nutrition Services, Lincoln, NE.

A commercial feedlot experiment was conducted to compare a Synovex Choice/Synovex Choice (Ch/Ch) implant strategy to a Revalor-IS/Revalor-S (IS/S) strategy on beef finishing steers performance and carcass characteristics. Crossbred calf-fed steers ($N=892$; 291 ± 20.81 kg BW) were blocked (6 blocks) by arrival date and assigned randomly to 12 pens. Pens were assigned randomly to one of two treatments (6 pens total/treatment). Treatments consisted of two implant strategies consisting on an initial implant of Synovex Choice followed by a second dose of Synovex Choice at reimplant, or Revalor-IS followed by Revalor-S. Second doses were administered at 90 days after first implant. Steers were fed the same diets for an average of 171 d and harvested at a commercial abattoir. Steers implanted with Ch/Ch had higher ($P=0.03$) ADG than steers implanted with IS/S when calculated from live final BW, with ADG of 1.81 and 1.79 kg/d respectively. Steers implanted with Ch/Ch were more efficient ($P=0.02$) on a live performance basis as well compared to IS/S because DMI was not different between the treatments ($P=0.81$). Hot carcass weight was not different ($P=0.57$), therefore no differences ($P=0.25$) were observed in ADG or G:F between the two implant programs on a carcass adjusted basis. Marbling score was numerically higher ($P=0.17$) for Ch/Ch compared to IS/S with scores of 531 vs. 514, respectively, and calculated USDA Yield Grade was higher ($P=0.03$) for steers implanted with Ch/Ch vs. IS/S steers suggesting a higher fat endpoint. Using Ch/Ch appears to produce similar or slightly better feedlot performance without impacting carcass quality compared to a more aggressive implant program.

Key Words: Feedlot cattle, Implants strategies

169 The effects of Paylean and lipoic acid on glycogen concentrations in the pork Longissimus muscle during the first 24 h postmortem. G. Rentfrow*, C. C. Carr, D. J. Kemp, C. D. Hardin, and E. P. Berg, University of Missouri, Columbia.

Twenty-four crossbred barrows (Hampshire x Yorkshire) were used to characterize the effects of Paylean and lipoic acid supplementation on glycogen concentration in the pork Longissimus muscle. Pigs were ultrasounded, weighed, and blocked into treatments stratifying to percent muscle. The treatment delivery system used 40 g of nursery pig starter diet moistened into a dough, then supplemented with 18 mg Paylean (PAY), 300 mg of lipoic acid (LA) or both PAY + LA (COMBO). Controls (CON) received dough balls only. The four treatments were hand fed to each pig twice daily (0800 and 1800 h) for 31 d. Pigs were given *ad libitum* access to water and a corn-soybean meal finishing diet. On the morning of d 32 the pigs were slaughtered according to humane harvesting practices at the University of Missouri abattoir. Immediately after electrical stunning (0 min) a muscle biopsy from the left side was taken at approximately 10 cm anterior to the Gluteus medius - Longissimus dorsi juncture with a spring loaded biopsy gun and immediately frozen in liquid nitrogen for muscle glycogen determination. This procedure was repeated at 45 min, 6, and 24 h postmortem at approximately 10 cm anterior of the previous biopsy site. Data was analyzed using the Proc Mixed procedure of SAS with a repeated measurement statement. Total muscle glycogen levels were higher ($P<0.01$) at 0 and 45 min than at 6 and 24 h for all four treatments. The addition of PAY to the diet caused numerically higher total muscle glycogen levels at all four postmortem time points. These data indicate that PAY supplementation increases total glycogen concentrations in the Longissimus muscle.

Key Words: PAY, LA, Glycogen

170 A novel procedure to identify off-flavored beef steaks. B. Jenschke*¹, A. Hamling¹, J. Hodgen¹, J. Meisinger¹, D. Moss¹, M. Lundesjö Ahnström², and C. Calkins¹, ¹University of Nebraska, Lincoln, ²Swedish University of Agricultural Sciences, Uppsala, Sweden.

Study of off-flavors in beef is limited by the number of samples that are available. This research was conducted to create a method of identifying off-flavored beef samples in a commercial meat plant. Beef knuckles were selected and held on a commercial beef fabrication line. A thin (2-4 cm) slice (about 10 g) of M. Rectus femoris was removed and cooked in an electric skillet. Two highly trained panelists independently smelled each sample during cooking in an electric skillet to identify possible candidates for off-flavor. A binary rating scale was used, in which either **••** or **•** was determined for the presence of off-flavor. Candidate muscles were retained and the remaining beef knuckles were returned to the fabrication process. Beef knuckles ($n=328$) were tested from five different feedlots and 30 candidates for off-flavor were identified. Feedlot A had 5.0% off-flavored samples (1 of 20), feedlot B had 9.4% (5 of 53), feedlot C had 6.7% (10 of 148), feedlot D had 12.5% (9 of 72), and feedlot E had 14.3% (5 of 35). An additional 30 knuckles were purchased that were rated as having no off-flavor by the panelists.

After a 7 d aging period, the testing was repeated in a laboratory setting. The two panelists independently sniffed or sniffed and tasted samples. A kappa statistic, which is similar to a correlation coefficient, was computed to assess the degree of agreement between the two panelists. The in-plant sniff test had a kappa statistic of 0.56 with a 95% confidence interval of 0.36-0.77 while the laboratory sniff and taste test on the same samples had a kappa statistic of 0.76 with a 95% confidence interval of 0.59-0.93. These data suggest the sniff and taste test can be used to identify off-flavored samples. Frequency of off-flavor appears to differ across feedlots.

Key Words: Beef flavor, Off-flavor

171 Protocol for determining volatile compound differences between liver-like and normal beef samples using gas chromatography. J. Hodgen*, C. Calkins, and S. Cuppett, *University of Nebraska, Lincoln*.

Liver-like off-flavors have been reported in some beef cuts. The objective of this research was to identify differences in volatile compounds from beef rated as normal or liver-like in flavor. Beef steaks were rated for off-flavors by a trained panel. Samples of comparable composition were chosen for this study based on descriptions by panelists as having a liver-like off-flavor or having no off-flavor (normal). Five grams of powdered meat samples from the *M. rectus femoris* and 100 mL of distilled water were mixed and flushed with nitrogen gas in a 40°C water bath. Times for the release of off-odors were collected. Two time periods, 0:36-2:40 min and 5:20-6:00 min, had undesirable aromas for the liver-like samples not found in the normal samples. Volatile compounds were trapped in a packed porous polymer column attached to the outlet of the gas dispersion flask for 0-5 min. A second column was attached for 5-10 min. The columns were flushed with ether (2 ml), and extracted samples were captured and stored in a glass vial. Ether samples were run on a gas chromatograph (GC) with oven conditions starting at 35°C, raising 2°C/min until 200°C was reached, and held for ten minutes. A 30 m 5% phenyl-95% methylpolysiloxane GC column with an inner diameter of 0.32 mm and film thickness of 0.25 Mm was used. Normal samples demonstrated approximately six peaks not present in the liver-like samples, while the liver-like samples showed approximately three peaks not present in the normal samples. Eight peaks differed in intensity in the two types of samples. Therefore, there are volatile compound differences in the two types of samples. Efforts are under way to discover the identity of the different compounds.

Key Words: Beef, Volatile compounds, Gas chromatography

172 Assessing the foodservice potential for muscles from the chuck. C. Bratcher*, K. Moore, M. Keene, and C. Lorenzen, *University of Missouri, Columbia*.

The objective of this study was to determine if selected muscles from the beef chuck have potential in the foodservice industry. USDA Select two piece, square cut chucks and briskets (n=25) were fabricated to

produce the following muscles: *Complexus (C)*, *Serratus ventralis (SV)*, *Rhomboides (R)*, and *Pectoralis superficialis (PS)*. Yield data was collected to determine the amount of each muscle useable in a foodservice setting. Water holding capacity, marinade uptake, thiobarbituric acid reactive substances (TBARS) for raw and cooked muscles, and proximate analysis were performed for each muscle. A chef focus group (n = 12) was recruited from the Missouri Restaurant Association to determine desirability of raw muscles in regard to foodservice usage and an economic analysis was conducted based on focus group outcomes. SV had the highest yield of the three muscles from the boneless chuck with weight of 13% total yield, followed by C (7%) and R (4%). Yield of PS was 28% of the total brisket. SV had a higher percent drip loss ($P < 0.05$) than C. SV had the highest percentage ($P < 0.05$) of marinade uptake indicating the greatest potential for incorporating flavor. Intermediate values were found for C and R and were not different ($P > 0.05$). The lowest marinade uptake was PS which was not different than R ($P > 0.05$). TBARS values for cooked and raw muscles were low with no differences between muscles ($P > 0.05$). Protein, fat and moisture were different between all muscles selected ($P < 0.05$), indicating that each muscle is unique in nutritional profile. Based on chef focus group and economic analysis, it was determined that depending on other uses for the rest of the chuck, it could be possible to retain value of the chuck by separating out R and C. Threshold values given by the chefs were \$5.51/kg for R and \$6.61/kg for C. Breakeven for the two muscles combined was calculated at \$6.06/kg. This was \$0.55/kg more and \$0.55/kg less than threshold for R and C respectively. Other muscles studied were not perceived as potential candidates for the foodservice industry.

Key Words: Beef, Value, Foodservice

173 Ranking beef muscles for Warner-Bratzler shear force and trained sensory panel ratings. G. Sullivan*¹, B. Gwartney², and C. Calkins¹, ¹*University of Nebraska, Lincoln*, ²*National Cattlemen's Beef Association, Centennial, CO*.

Meat scientists have studied the tenderness and sensory traits of beef muscles for many years. Few, however, have characterized these traits for a large number of different muscles. The objective of this project was to rank the major beef muscles for shear force and sensory traits based on a comprehensive study of the literature, thereby basing the rank on a large number of samples for each muscle. Over 50 papers were selected, ranging in publication date from 1945 to 2005. Only papers studying three or more muscles from three or more animals were included. Those used to rank muscles for Warner-Bratzler shear force used 1.3 cm cores. Endpoint temperatures ranged from 70 to 77°C. Up to 39 muscles were ranked for shear force (n=39), sensory tenderness (n=16), juiciness (n=15), and beefy flavor (n=9). Sensory ratings were expressed as a percentage of the rating scale to allow equitable comparisons. The psoas major and the infraspinatus were among the best ranked muscles for shear force and tenderness. For muscles ranked in both lists, the semi-membranosus, semitendinosus, gluteus medius, supraspinatus, and the deep pectoral were among the least tender. The correlation between the least square means for shear force and tenderness rating was 0.63 ($P < 0.01$). However, the correlation of ranking for the 16 muscles found in both lists was just 0.32 ($P > 0.21$), indicating the relationship between shear force and tenderness rating is not consistent across muscles. This is likely due to differences in connective tissue. For juiciness, the serra-

tus ventralis and the infraspinatus were among the best. Among the least juicy were the semimembranosus, semitendinosus, and the adductor. Beefy flavor showed little variation among the nine muscles ranked. These rankings may be useful for those seeking to identify muscles with particular shear force and sensory characteristics.

Key Words: Beef tenderness, Shear force, Juiciness

174 Concentrate level effects on carcass traits of Boer cross-bred goats. S. Ryan*, J. Unruh, M. Corrigan, J. Drouillard, and M. Seyfert, *Kansas State University, Manhattan*.

Boer cross-bred goats (n=46) were used to assess the effects of dietary concentrate on carcass composition, primal cut yield, sensory properties, and fatty acid (FA) composition. Goats were fed diets ad libitum with no concentrate (range) or one of three levels of concentrate (low, 50%; medium, 70%; and high, 90%) for 126 d before slaughter. Carcass measurements were taken at 24 hr postmortem before carcasses were fabricated according to Institutional Meat Purchase Specifications (Hotel Style). Sensory, cooking loss, shear force, and fatty acid composition

were determined on *longissimus* samples. No differences ($P > 0.05$) were observed among the three levels of concentrate feeding except carcasses from goats fed a low concentrate diet had a higher ($P < 0.05$) percentage of trimmed shoulder than carcasses from goats fed a medium level of concentrate. In linear contrasts comparing range and concentrate feeding, goats fed concentrate diets had *longissimus* muscles with greater ($P < 0.05$) a*, b*, hue angle and chroma values than those fed range diets. Feeding concentrate diets increased ($P < 0.05$) live weight, hot carcass weight, dressing percent, ribeye area, actual and adjusted 13th rib fat, body wall width, leg circumference, carcass length, marbling score, kidney and pelvic fat compared to range-fed goats. Chops from goats fed concentrate diets had more ($P < 0.05$) off flavor intensity and cooking loss than chops from range-fed goats. Concentrate-fed goats had greater ($P < 0.05$) values for leg; trimmed leg; loin; trimmed loin; rack; trimmed rack; shoulder; trimmed shoulder; trimmed leg, loin, rack and shoulder; foreshank; ribs and breast; and flank than range goats, but lower percentages of trimmed leg; trimmed rack; trimmed shoulder; and trimmed leg, loin, rack and shoulder. Chops from goats fed concentrate diets had greater ($P < 0.05$) total percentage of total FA and *n*-6 FA but lower percentages of *n*-3 FA than chops from range-fed goats. Goats fed concentrate diets had heavier carcasses and primal weights but lower percentages of primal cuts and more off flavor intensity than range-fed goats.

Key Words: Goat, Composition, Meat quality

Nonruminant Nutrition - Grow-Finish Nutrition

175 Amino acid compositions of two genotypes of barrows and gilts during the grower finisher period. T. Wiseman*, D. Mahan, J. Peters, N. Fastinger, S. Ching, and Y. Kim, *The Ohio State University, Columbus*.

Two genotypes of pigs with different lean gain potentials (280 vs. 350 g FFL/d) were used to evaluate total body amino acid composition from 18 to 127 kg BW in five weight groups. Both genotypes had equal distributions of gilts and barrows (n = 120 total), were housed at a single site, and fed common diets during the nursery period. The experiment was a 2 x 2 x 5 RCB design conducted in two groups. At an average 18 kg BW the pigs were moved to a complete confinement facility and split sex fed a corn-soybean mixture that met or exceeded NRC (1998) amino acid and mineral requirements for each genotype for their lean gain potential. A total of six pigs for each treatment group were harvested initially and at approximately 27 kg intervals thereafter to 127 kg BW. Pigs were harvested as they reached their pre-allotted harvest weight with individual pigs being the experimental unit. Carcasses were split along the dorsal midline with the right side and internal tissue analyzed for amino acid content. The results demonstrated a linear increase ($P < 0.01$) in total body essential- and nonessential amino acid contents from 18 to 127 kg BW. Pigs of higher lean gain potential had higher essential amino acid levels ($P < 0.01$), than pigs with the lower lean gain. The differences in essential amino acids were initially evident at 18 kg BW with the lean genotype having greater contents, but the differences were more pronounced as body weight increased, resulting in a weight x genotype interaction ($P < 0.01$). Nonessential amino acids contents were higher ($P < 0.01$) in lean genotype pigs with the exception of glycine ($P < 0.03$). Gilts had higher essential amino acid than barrows ($P < 0.05$), but the gilts were also leaner ($P < 0.01$) suggesting that the

greater amino acid content of the gilts was reflective of their lean content. These results suggest that pigs of higher lean gain potential and gilts have higher body concentrations of amino acids.

Key Words: Amino acid, Body composition, Pigs

176 The effect of diet on the occurrence of osteochondrosis dissecans and cartilage properties in pigs. N. Frantz*, J. Nelssen, G. Andrews, M. Tokach, S. Dritz, T. Loughin, R. Goodband, and J. DeRouchey, *Kansas State University, Manhattan*.

An 84-d study with 80 gilts (initially 39 kg BW) was conducted to determine the effects of dietary nutrients or additives related to cartilage and bone metabolism on the occurrence of osteochondrosis dissecans (OCD) and cartilage properties. Dietary treatments were: 1) control (corn, soy, 3% choice white grease), or the control diet with added: 2) fish oil as the added fat source, 3) proline and glycine (300 and 200% of lysine), 4) leucine, isoleucine, and valine (BCAA; 200, 100, and 100% of lysine, respectively), 5) silicon (1000 ppm), 6) Cu and Mn (250 and 100 ppm), 7) methionine and threonine (150 and 100% of lysine), and 8) combination of diets 2 through 7. The distal aspect of the left femur was evaluated for OCD lesions. Each femur was sliced into 3 mm sections and assigned a severity score for surface abnormalities, the underlying articular cartilage, and physal growth plate. Also, cartilage samples were tested for compression and shear properties. Growth performance ($P > 0.21$) and cartilage compression values ($P > 0.51$) were unaffected by diet. Shear values were lower ($P < 0.02$) in pigs fed fish oil and the ratio of compression/shear was higher ($P < 0.03$) in pigs fed fish oil or proline/

glycine. Pigs fed diets containing fish oil or silicon tended to have higher surface abnormality severity scores ($P < 0.06$) than pigs fed BCAA, methionine/threonine, or the combination diet. Pigs fed the control diet tended to have higher underlying articular cartilage severity scores ($P < 0.09$) than pigs fed fish oil, proline/glycine, silicon, Cu/Mn, or methionine/threonine. Occurrence of growth plate lesions was unaffected by diet ($P > 0.18$). Total severity score tended to be reduced ($P < 0.14$) in pigs fed methionine/threonine or the combination diet compared with pigs fed fish oil or the control diet. In summary, these data indicate that feeding nutrients or additives related to cartilage metabolism tended to influence the severity of OCD lesions.

Key Words: Pigs, Osteochondrosis, Cartilage

177 Effects of continuous or intermittent ractopamine HCl feeding on late finishing pig growth performance. C. N. Neill*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, J. M. DeRouchey, C. N. Groesbeck, and K. R. Brown, *Kansas State University, Manhattan, KS*.

A total of 110 barrows (PIC) with an initial BW of 70.0 kg were used in a 56-d growth trial with 2 pigs per pen and 11 pens per treatment to evaluate the effects of continuously feeding Ractopamine HCl (RAC), RAC withdrawal, or intermittent RAC feeding on finishing pig performance. Diets were sorghum-soybean meal-based and formulated to contain 1.0% lysine with or without 10 ppm RAC. The five treatments were: 1) control diet (no RAC) fed for 56 d; 2) RAC fed for 56 d; 3) RAC fed for 21 d, control for 14 d, then RAC for 21 d; 4) control fed for 7 d, RAC fed for 21 d, control fed for 7 d, then RAC fed for 21 d; and 5) control fed for 35 d, then RAC fed for 21 d. There was a treatment by week interaction for ADG ($P < 0.001$). From d 0 to 21, pigs fed RAC had increased ($P < 0.001$) ADG and G:F compared with pigs fed the control diet. Pigs fed RAC for 56 d had greater ($P < 0.05$) ADG and G:F from d 0 to 21, but were not different from control pigs by d 56 (see table). When RAC was fed for 21 d then withdrawn for either 7 or 14 d and re-fed for 21 d, these pigs had the same overall ADG and G:F as pigs only fed RAC the last 21 d. Pigs fed RAC for only the last 21 d had increased ($P < 0.05$) ADG compared with control pigs. In conclusion, withdrawing RAC for 7 or 14 d after feeding for 21 d and re-feeding for 21 d provided a similar response to feeding RAC for only the last 21 d before market.

Table 1. Ractopamine fed during these days

Item	None	0 to 21 and		7 to 28 and		SE
		0 to 56	35 to 56	35 to 56	35 to 56	
ADG, kg	1.01 ^b	1.04 ^{ab}	1.08 ^{ab}	1.08 ^{ab}	1.10 ^a	0.043
ADFI, kg	3.43	3.29	3.45	3.36	3.51	0.111
G:F	0.29	0.32	0.31	0.32	0.31	0.012

^{ab} Means in the same row without common superscript differ ($P < 0.05$).

Key Words: Finishing pig, Intermittent, Ractopamine withdrawal

178 The effects of increased dietary energy concentration on the performance and economics of growing-finishing pigs housed in a commercial facility. A. D. Beaulieu*, J. F. Patience, M. Rivard, and D. Gillis, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada*.

If gut capacity is limiting energy intake, then increasing dietary energy concentration should improve growth. In a previous experiment however, no difference in performance was observed among pigs receiving diets with increased DE. The objective of the present experiment was to examine the performance and economic impact of elevating the dietary energy concentration in the diet of growing-finishing pigs housed under commercial conditions. A commercial barn was chosen to provide an environment different from that used in previous studies. A total of 720 pigs (36.85 ± 0.98 kg, mean \pm SE), blocked by gender and initial weight, were assigned to receive diets formulated to contain 3.20, 3.35 or 3.50 Mcal DE/kg. Dietary energy was increased by wheat and tallow (maximum 4%) replacing barley. A constant dlys:DE ratio was maintained across treatments and decreased as the pigs grew. Actual DE concentration, determined at the mid-point of each of three phases, averaged 3.12, 3.30 and 3.43 Mcal/kg. From 37 to 80 kg BW, ADG (0.93, 0.98, 1.03 ± 0.05 kg/d) and feed efficiency (0.40, 0.41, 0.43 ± 0.01 ; 3.12, 3.30, 3.43 Mcal/kg respectively) improved with increasing dietary energy ($P < 0.05$). Feed intake was unchanged ($P > 0.10$); thus DE intake increased with increasing DE concentration ($P < 0.05$). Conversely, from 80 to 120 kg BW, ADFI decreased as DE concentration increased ($P = 0.02$) and ADG and feed efficiency were similar among treatments ($P > 0.05$). Treatment did not affect carcass backfat thickness, lean yield, index, or value ($P > 0.10$). Loin thickness tended to increase with DE concentration ($P = 0.08$). The coefficient of variability of BW on d 57 (first pull) averaged 12.2, 11.5 and 12.2% for the 3.12, 3.30 and 3.43 Mcal DE/kg treatments, respectively. An economic analysis, conducted using 5 yr mean feed and market prices, indicated an advantage for the lower energy diets. Increased dietary energy concentration improved the growth of commercially housed pigs, but only up to 80 kg BW. Overall (37 to 120 kg) performance was not affected by dietary energy concentration.

Key Words: Swine, Dietary energy, Tallow

179 Evaluation of yellow field peas in growing-finishing swine diets. G. I. Petersen* and J. D. Spencer, *JBS United, Inc., Sheridan, IN*.

This study evaluated the effects of feeding yellow field peas (WFP 0097) as a replacement for corn and soybean meal in pig growing-finishing diets. Pigs (750 Ausgene x Ausgene) were allotted to one of three treatments in a randomized complete block design trial with ten replicate pens per treatment. Pigs were allotted by sex and placed in pens (25 pigs per pen) allowing for 0.74 square meters per pig. Treatments consisted of a corn-soybean meal control, a low pea inclusion with peas added to replace approximately 45% of the soybean meal in the control treatment, and a high pea inclusion that replaced 100% of the soybean meal in the control treatment. Pigs were fed in five phases during the course of the trial. The five phases were fed from 30-45 kg, 45-65 kg, 65-80 kg, 80-100 kg, and 100-120 kg. All diets were formulated to contain similar energy and digestible lysine concentrations, and were adequate in all other nutrients. All peas and corn used for diet formulation were ground through a roller mill. Pigs had ad libitum access to feed and water throughout the trial. Body weight and feed intake measurements were taken weekly for the initial four weeks, then every

three weeks for the remainder of the trial. Results showed that the inclusion of peas did not affect ($P > 0.05$) overall ADG or ADFI. However, week two and overall G:F (0.327 vs 0.324) were lower ($P < 0.05$) in pea-containing diets than in the control diet. In week three, ADG tended to be lower ($P < 0.09$) for pigs fed the diets containing peas compared to those fed the control. It is believed that these early differences were due to a larger particle size of the ground peas as corn particle size ranged from 549-599 microns and pea particle size ranged from 725-792 microns in weeks 1-4. After adjustments to equalize particle size, performance was equal among treatments for the remainder of the trial. Field peas can be used as a protein and energy source in growing finishing pigs diets, and can fully replace soybean meal when diets are formulated to meet nutrient requirements. Although a slight reduction in feed efficiency occurred when diets contained peas, the difference in milling characteristics may have contributed to this reduction in performance.

Key Words: Field pea, Particle size, Pig

180 Hulless barley and hulless oats in piglet diets - effect on growth performance. N. P. Kjos* and M. Øverland, *Norwegian University of Life Sciences, Aas, Norway.*

The objective was to evaluate the effect of hulless barley (Exp. 1) and hulless oats (Exp. 2) on growth performance of piglets. In Exp. 1, a total of 80 piglets (10.8 kg and 31.9 kg initial and final BW) were used. Pigs were allotted to four dietary treatments with increasing levels of hulless barley at the expense of hulled barley (0, 32, 64 and 97% of the grain as hulless barley, respectively). There were four pigs per pen, and five replicate pens per treatment. In Exp. 2, a total of 64 piglets (11.1 kg and 32.9 kg initial and final BW) were used. Pigs were allotted to four dietary treatments where increasing levels of hulless oats replaced hulled oats (0, 24, 51 and 76% of the grain as hulless oats, respectively). There were four pigs per pen, and four replicate pens per treatment. In both Exp. 1 and 2 the diets were based on grains (barley/oats and wheat), soybean meal, fish meal, and soy oil. Pigs were allotted to the dietary treatments according to initial BW, sex and litter in a randomized complete block design. The experimental period was 35 days. Pigs had free access to feed and water. There were no significant effects of increasing levels of hulless grains (barley and oats) on ADG, ADFI or gain/feed (G/F) in both Exp. 1 and 2. In Exp. 1, increasing levels of hulless barley gave the following ADG: 610 g; 623 g; 584 g; and 601 g, and G/F: 0.69; 0.67; 0.65; and 0.66. In Exp. 2, increasing levels of hulless oats gave the following ADG: 612 g; 577 g; 653 g; and 642 g, and G/F: 0.64; 0.68; 0.67; and 0.68. The results indicate that hulless barley and oats can be used in diets for weaned piglets without adversely affecting growth performance. Because the energy and protein concentration is higher in hulless

grains compared to hulled grains, the inclusion of hulless grains makes it feasible to reduce the level of soybean meal and soy oil in the diets. This is of importance in Norway, because the use of hulless grains allows for increased use of domestic feed ingredients.

Key Words: Piglets, Hulless grains, Growth

181 Voluntary feed intake and nutritive value of aquatic ferns (*Azolla filiculoides* and *Salvinia molesta*) in swine. P. Leterme*^{1,2}, A. M. Londoño², D. C. Ordoñez², J. A. Suarez², C. A. Bedoya², L. S. Muñoz², and A. Buldgen³, ¹*Prairie Swine Centre Inc., Saskatoon, SK, Canada*, ²*Universidad Nacional de Colombia, Palmira, Valle, Colombia*, ³*Faculte des Sciences agronomiques de Gembloux, Gembloux, Belgium.*

Aquatic ferns (AF) like *Azolla filiculoides* and *Salvinia molesta*, are grown on swine lagoons in the tropics in order to recycle nutrients and to reduce the impact of pork production on the environment. The AF are used as sources of minerals and proteins in swine diets. The present work aimed to determine: 1) the voluntary feed intake (VFI) of AF as either fresh or dried and ground; 2) fecal and ileal protein digestibility of AF in piglets (18 kg), growing pigs (60 kg) and adult sows (235 kg) at different dietary incorporation rates and 3) the effect of AF intake on the gastrointestinal tract morphology of growing pigs and adult sows. *Azolla* contained from 236 to 251 g CP and from 619 to 632 g NDF/kg DM, and *Salvinia* from 112 to 169 g CP and from 620 g to 630 g NDF/kg DM. VFI was measured on 100 kg-pigs receiving a diet containing 600 g concentrate and 400 g AF per kg. The VFI of *Azolla* and *Salvinia* reached 1240 and 1428 g DM/d, respectively, when the AF were presented in dry form and 630 and 600 g DM/d when presented in fresh form (9.0 and 9.7 kg of fresh AF/d). For the digestibility studies, the piglets received 0, 100 and 200 g AF/kg diet, the growing pigs 0, 125 and 250 g/kg and the adult sows 0, 150 and 300 g/kg. The fecal protein digestibility of the diets decreased linearly ($P < 0.001$) as the incorporation rate of AF in the diet increased. The decrease in ileal protein digestibility was quadratic ($P < 0.001$) and decreased more abruptly at high incorporation rates. The rate of decline was also greater for piglets, compared to growing pigs and adult sows. The stomach, small intestine, cecal and colonic weights, the small and large intestine lengths and the pH of the content of these respective organs were not affected ($P > 0.1$) by AF intake. In conclusion, high VFI of aquatic ferns in pigs is possible and will not affect the morphology of the gastrointestinal tract. They can be considered for pig feeding but incorporate rates in the diets should not exceed 200 g AF/kg because over that level, digestibility is affected.

Key Words: Swine, Aquatic ferns, Feed value

Odor and Nutrient Management

182 Feedlot pen surface conditions and their effect on ammonia emissions using forced-air wind tunnels. D. Sherwood*, G. Erickson, T. Klopfenstein, D. Schulte, and R. Stowell, *University of Nebraska, Lincoln*.

It is not well known how cattle feedlot surface conditions influence ammonia (NH₃) emissions. A summer trial was conducted to determine differences in the net flux of NH₃ being volatilized from four different treatments. Treatments were applied to 0.54 m² plots on a feedlot pen as a 2x2 factorial, with moisture (15 L; DRY or WET) and/or URINE (1 L) added. Treatments were applied once; prior to the first NH₃ flux measurement. Forced-air wind tunnels were used to measure NH₃ flux from each treatment every 3-h on d 1 until 2100, and every 6-h on d 2. The two day collection was repeated weekly for three weeks. Wind tunnels directed air over the surface at 0.3 m/s for 30 minutes per plot. A fraction of the air flow (0.024 m³/s) was diverted for analysis and NH₃ was collected using a 0.2 M sulfuric acid trap. One inch cores were taken from each plot, two at the beginning of d 1 and two at the end of d 2, and were analyzed for DM, pH and N. Surface and soil temperatures were recorded at the beginning of each 30 minute collection period. There were no moisture*time*urine or urine*time interactions, or main effect of urine. A moisture*time interaction (P = 0.03) was observed for NH₃ flux. The net flux was different (P < 0.01) during collections before 0900 on both d 1 and 2 with 3.07 and 2.09 Mg/s⁻¹/m⁻² for DRY and 0.65 and 0.72 Mg/s⁻¹/m⁻² for WET; whereas measurements taken after 1200 were much lower (0.21 DRY, 0.18 WET). Core N (% DM) was not different across treatments and did not include the surface where urine was directly applied. pH was lower (P < 0.01) for DRY and DRY+URINE (7.99) compared to WET and WET+URINE (8.27). NH₃ flux correlates to both core N (r = 0.367, P = 0.02) and moisture (r = -0.334, P = 0.04), but not temperature (P = 0.52 and 0.39) in this study. In this trial, NH₃ loss appears to be related to soil moisture with greater loss from dry surfaces (moisture = 11.7%). NH₃ loss followed a diurnal pattern, with loss greatest prior to 0900. No effects of urine addition were detected.

Key Words: Ammonia, Emissions, Feedlot cattle

183 Influence of dietary manipulation on DM, N, and P excretion of pigs during an entire finishing period. M. Lachmann*, S. Carter, T. Buhay, S. Jenkins, and Z. Marable, *Oklahoma State University, Stillwater*.

A total of 48 Yorkshire barrows (30.2 kg BW) was used to determine the effect of reducing dietary CP and P on DM, N, and P excretion during a 112-d finishing period. Pigs were blocked by BW and allotted randomly to two dietary treatments. Pigs were housed in an environmentally-controlled building divided into 4 identical rooms (12 pigs/room, 2 rooms/trt) with each having a shallow pit, pull plug system. A fortified corn-soybean meal-based diet served as the control (18, 16, and 14% CP; 0.50, 0.45, and 0.40% P for Phases 1, 2, and 3, respectively). The experimental diet (LPP) was similar to the control diet with the exception that CP was reduced by 4% units and P by 0.1% units. Both diets were formulated on true dig. Lys (0.83, 0.71, and 0.58%), and Thr, Met,

and Trp were added to LPP on an ideal basis. Pigs and feeders were weighed weekly, and pit volume and pH were measured. Weekly feed and pit samples were collected for DM, N, and P analysis. The avg concentration of DM (0.55%) in the pit was similar (P > 0.10), but N (12.6 vs. 7.4%) and P (2.47 vs. 1.90%), on a DM basis, were reduced (P < 0.02) for pigs fed LPP. Pit pH (7.0 vs. 6.2) tended to decrease (P < 0.08) with LPP. Days on test increased (P < 0.05) for pigs fed LPP (105 vs. 112 d), but final weight (108.3 kg) and DMI (1.86 kg/d) were not affected (P > 0.1). However, N (53 vs. 38 g/d) and P (9.3 vs. 7.1 g/d) intakes were reduced (P < 0.01) for pigs fed LPP. Daily DM excreted was similar (P > 0.01) between diets (274 vs. 269 g/d). Pigs fed LPP had a marked decrease (P < 0.05) in N (34.7 vs. 20.6 g/d) and P (6.8 vs. 5.1 g/d) excreted. Excretion (% of intake) was similar (P > 0.10) for DM (14.5%) and P (72%), but N tended to be reduced (P < 0.10) for pigs fed LPP (65 vs. 53%). For pigs fed LPP, cumulative N and P excreted for the entire 112-d period tended to be reduced (P < 0.10) by 1.59 and 0.139 kg/pig. Based on these results, the LPP diet reduced daily and total N and P excreted by 40 and 25%, respectively, during a 112-day finishing period.

Key Words: Pigs, Diet, Nutrient excretion

184 Influence of diet on macro- and micro-mineral excretion of pigs during an entire finishing period. M. Lachmann*, S. Carter, T. Buhay, S. Jenkins, and Z. Marable, *Oklahoma State University, Stillwater*.

As part of a larger study to examine the effects of diet on N, P, and DM excretion over a 112-d finishing period, the effects of diet on mineral excretion were determined. A total of 48 Yorkshire barrows (30.2 kg BW) was blocked by BW and allotted randomly to two dietary treatments. The control diet was a fortified corn-soybean meal diet and Diet 2 was a reduced CP, low P (LPP) diet. The LPP diet was similar to the control diet with the exception that CP and P were reduced by 4% units and 0.10% units. The reduction in CP and P of the LPP diet reduced soybean meal, limestone, and dicalcium phosphate levels, which are sources of minerals. The diets were formulated to similar dig. Lys, Ca:P ratio, and contained the same level of trace mineral premix. Pigs were housed in an environmentally-controlled building divided into 4 identical rooms with each having a shallow pit, pull plug system. There were 12 pigs/room (2 rooms/trt). Pigs and feeders were weighed weekly and pit volume recorded. Weekly feed and pit samples were collected for mineral analysis (Ca, K, Mg, Na, Fe, Zn, Cu, Mn). Daily mineral intake was similar (P > 0.10) for Na, Cu, and Mn; however, the daily intakes of Ca, K, Mg, Zn, and Fe were reduced (P < 0.05) for pigs fed LPP. Although mineral intake, in some instances, was reduced for pigs fed LPP, daily mineral excretion was not affected (P > 0.10) by diet, with the exception of K and Mn, which tended to be reduced (P < 0.10) by LPP. Generally, mineral excretion (% of intake) was not affected (P > 0.10) by diet, except for Ca, which tended to be increased (P < 0.10) by LPP. However, the excretion of Na and Mg exceeded greatly the amount consumed via the diet, likely due to intake via water. Also, the excretion of Fe, Zn, Cu, and Mn was approximately 100% of intake. These results suggest that the diets employed had little effect on mineral excretion.

tion over the course of a 112-d period. Notably significant is the fact that mineral excretion equaled, or in some cases exceeded, the amount consumed via the diet.

Key Words: Pigs, Diet, Mineral excretion

186 Reduction of aerial ammonia and amine from manure of pigs fed a probiotic. S. K. Kommera*, R. D. Mateo, C. Lin, and S. W. Kim, *Texas Tech University, Lubbock*.

A probiotic (Cleo®, Easybio System Inc) containing *Lactobacillus plantarum*, *Lactobacillus salivarius*, *Bacillus licheniformis*, *Bacillus subtilis* was added to pig diets to test its effect on reducing odor emission from pig excreta. Eighty 28 d old pigs were allotted to two treatments: the CON (without any probiotics) and the PB (with the probiotic at 0.1%). There were 5 replicates per treatment and 8 pigs per pen. Pigs were fed the assigned diets ad libitum for 5-wk. Weight gain and feed intake of pigs were measured weekly. From wk 3, all pigs in each pen were moved to a pen (1.2×2.4 m) in a ventilated environmental chamber (3.0×3.0×2.4 m) for 48 h to measure 42 h aerial ammonia,

amine, and hydrogen sulfide production from the pigs under controlled conditions. The chamber fan was working continuously and constantly during the experimental period and treatments alternated entering the chamber. Two gas monitors (Pac III® and Miniwarm®, Draeger Safety, Inc., Pittsburgh, PA) with sensors for ammonia, amine, and hydrogen sulfide were placed in the chamber to measure aerial concentration of ammonia, amine, and hydrogen sulfide during the 42 h period at 10 min intervals. Feed intake and weight gain of pigs during the 48 h period were measured. After the measurement, the pigs were returned to the original pens to finish the 5 wk feeding period. The ADG, ADFI, gain:feed did not differ ($P=0.780$, 0.664 , and 0.960 , respectively) between the CON (402.8 g, 725.0 g, and 0.555, respectively) and the PB (396.0 g, 714.2 g, and 0.553, respectively) during the entire 5 wk feeding period. The final ammonia and amine levels at 42nd h were different ($P=0.045$ and 0.005 , respectively) between the CON (12.79 and 11.21, respectively) and the PB (8.92 and 6.11, respectively). Using the slope ratio analysis, the rates of increase of aerial ammonia and amine were smaller ($P<0.001$ and <0.001 , respectively) from the PB (0.004 and 0.126, respectively) than the CON (0.224 and 0.255, respectively). Hydrogen sulfide was not detectable during 48 h period. This study shows that ammonia and amine from pig excreta can be reduced by dietary supplementation of a probiotic with *Lactobacillus* and *Bacillus*.

Key Words: Pigs, Odor, Probiotic

Physiology Symposium - Role of the Ovary in Reproduction

187 Patterns of ovarian gene expression in pigs and cattle. M. C. Lucy*, C. Agca, and S. J. Kolath, *University of Missouri, Columbia*.

Reproductive tissues express mRNA for a large number of genes. Characterizing changes in mRNA expression is a powerful tool that can be used to understand the underlying mechanisms controlling ovarian development in farm animals. Sequencing projects typically find a large number of unique mRNA within the reproductive tract; thus, reproductive tissues are a rich source of novel mRNA. Most of the expressed genes in ovary are involved in metabolism and growth. There are also numerous genes whose identity and function are unknown. One of the most-highly expressed mRNA in porcine follicle (GenBank CO946569) has few homologs in any species and a completely uncharacterized function. One of the most highly expressed mRNA in porcine CL [beta-microseminoprotein (MSMB)] is not expressed in bovine CL and has no known function in porcine CL. Elongation factor 1 alpha (EEF1A1), cytochrome c oxidase, glutathione s transferase (GSTA2), vimentin (VIM), ATP synthase A chain, and translationally controlled tumor protein (TCTP) are highly expressed in both porcine and bovine follicles. There are other mRNA, however, that are highly expressed in either porcine follicle [(e.g., ferritin heavy chain (FTH1), prostaglandin-F synthase (PGFS), and cathepsin L (CTSL)] or bovine follicle [(e.g., osteonectin (SPARC), tissue inhibitor of metalloproteinase 2 (TIMP2), thrombospondin 1 (THBS), and gelatinase A (MMP2)]. The large differences in mRNA expression between species may encode mechanisms for the different patterns of follicular growth in pigs and cattle. A comparison of mRNA expression in bovine follicle and CL demonstrated follicle-specific and CL-specific mRNA but also mRNA that were highly expressed in both follicle and CL [(e.g., fibromodulin (FMOD), hypoxia-inducible factor 1 (HIF1A), UDP-galactose

translocator 2 (UGALT2), and paired basic amino acid cleaving enzyme (FURIN)]. The mRNA that are highly expressed in both follicle and CL may encode proteins that are essential for steroidogenic tissues. Microarray analyses have revealed patterns of mRNA expression under a variety of physiological conditions. New tools for genome analysis will greatly facilitate our understanding of gene expression in ovary.

Key Words: Ovary, mRNA, follicle

188 The physiological significance of the variation in numbers of follicles during follicular waves in cattle. J. Ireland*¹, G. Smith¹, D. Burns¹, F. Jimenez-Krassel¹, J. Ireland¹, P. Knight², F. Ward³, P. Lonergan³, and A. Evans³, ¹*Michigan State University, East Lansing*, ²*University of Reading, Reading, UK*, ³*University College, Dublin, Ireland*.

The physiological significance of the variation in numbers of follicles during follicular waves in cattle is unknown. After daily counting of all follicles > 3 mm in diameter during nearly 200 follicular waves (3 to 6 waves per animal), peak numbers of follicles per wave was highly variable among animals ($n = 8$ to 56), but highly repeatable (0.85 to 0.95) within individuals. Cattle with high numbers of follicles (> 25) during waves had nearly 50% lower ($P < 0.05$) serum FSH concentrations throughout the first non-ovulatory wave compared with cattle with low numbers of follicles (< 15). Beef heifers with high (> 25 , $n = 11$ cattle) or low (< 15 , $n = 12$ cattle) numbers of follicles per wave were superovulated, inseminated and flushed on Day 7. Response to superovulation, as measured by number of CL, was greater ($P < 0.05$, 17.6 ± 3.6 vs $8.5 \pm$

1.1) for heifers with high vs low numbers of follicles. Despite similar recovery rates of oocytes and embryos (61.8 vs 60%), twice as many oocytes and embryos (10.6 ± 2.7 vs 4.7 ± 0.7 , $P < 0.01$) and 42% more embryos of transferable quality (5.4 ± 1.3 vs 3.8 ± 0.8 , $P < 0.04$) were recovered per flush from heifers with high vs low numbers of follicles. However, the proportion of transferable embryos (transferable embryos/total embryos recovered) was lower (51 vs 80%, $P < 0.05$) in cattle with high numbers of follicles, implying that the number of high quality oocytes may be lower in cattle with high vs low numbers of follicles during waves. In conclusion, the variation in numbers of follicles during waves may be a useful phenotypic characteristic to identify not only cattle with a heightened responsiveness to superovulation, but also to improve superovulation procedures and further examine the causes and physiological significance of the variation in numbers of follicles during follicular waves.

Key Words: Follicle number per wave, FSH, Superovulation response

189 Relationship between follicle size and pregnancy success.

G. A. Perry*, *South Dakota State University, Brookings.*

Procedures that control the timing of ovulation in mammals are of enormous value in advancing the use of reproductive technologies. Most fixed-time insemination protocols (protocols that control ovulation) utilize gonadotropin-releasing hormone (GnRH) to induce ovulation. Administration of GnRH induces a surge of LH and ovulation. However, GnRH in fixed-time AI protocols results in the ovulation of a wide range of follicle sizes. Among both heifers and cows, the relationship between follicle size and pregnancy status following a fixed-time insemination protocol was quadratic. Small follicles induced to ovulate resulted in lower pregnancy rates, increased embryonic/fetal mortality, and a slower rise in subsequent progesterone concentrations compared to cows induced to ovulate larger follicles. In postpartum cows, there was no relationship between follicle size and pregnancy status for cows that spontaneously ovulated, but in heifers the relationship between follicle size and pregnancy status following spontaneous ovulation remained quadratic. Following fixed-time insemination, in both cows and heifers, animals that exhibited standing estrus at time of fixed-time insemination (± 24 hours) had greater pregnancy rates compared to animals that did not. Cows that exhibited estrus and were induced to ovulate medium or large follicles had preovulatory estradiol concentrations similar to cows that spontaneously ovulated and higher than cows not exhibiting estrus. Furthermore, cows not exhibiting estrus had lower preovulatory estradiol concentrations compared to cows that spontaneously ovulated. Cows that did not exhibit estrus and were induced to

ovulate had a longer interval from GnRH to ovulation compared to cows that did exhibit estrus or cows that spontaneously ovulated (interval from onset of estrus to LH surge). In summary, follicular maturity at time of GnRH-induced ovulation in both heifers and cows influenced pregnancy rates. Decreased preovulatory estradiol concentrations and timing of ovulation could explain the decreased pregnancy rates in cows that are induced to ovulate and do not exhibit standing estrus.

Key Words: Follicle Size, Estrus, Pregnancy

190 Progesterone protects the corpus luteum from prostaglandin F2A induced luteolytic responses in pig corpora lutea without luteolytic capacity. F. Diaz* and M. Wiltbank, *University of Wisconsin, Madison.*

The lifespan of the corpus luteum is precisely regulated as indicated by a remarkably constant luteal phase length of 13-14 days per cycle. Current methods available to shorten the luteal phase in other species are problematic in pigs because the CL is highly resistant to PGF2A-induced regression for almost the entire non-pregnant luteal phase. This is in contrast to the CL after day 13 of pregnancy (or pseudopregnancy) which is highly sensitive to PGF2A-induced luteolysis. We have described several pathways that are regulated by PGF2A specifically in CL with luteolytic capacity. For example, luteal production of PGF2A (autoamplification) and estradiol are upregulated and progesterone production downregulated by PGF2A only in CL with luteolytic capacity. Nevertheless, certain PGF2A signaling pathways are induced similarly in CL with or without luteolytic capacity, such as induction of certain AP-1 transcripts (c-fos, JunB), indicating that PGF2A signaling pathways are active in CL without luteolytic capacity. Recent evidence indicates that progesterone may protect luteal cells from cell death and thus it is possible that progesterone may also block PGF2A-induced luteolytic responses in CL lacking luteolytic capacity. We have tested the effect of acute inhibition of progesterone synthesis on PGF2A-induced luteolytic responses in CL without luteolytic capacity. Short-term treatment of pigs on day 7 for 36 hours with a 3BHS inhibitor (Epostane) promotes the ability of a single PGF2A treatment to upregulate pathways associated with luteolysis, including autoamplification of luteal PGF2A production and induction of the estradiol biosynthesis pathway. These data support the hypothesis that the action of progesterone blocks luteolytic responses in CL without luteolytic capacity. Furthermore, the loss of the protective effect of progesterone appears to be a critical part of acquisition of luteolytic capacity. A better understanding of the mechanisms associated with acquisition of luteolytic capacity may yield better methods for estrous synchronization and improved reproductive performance.

Key Words: Luteolysis, PGF2A, Corpus luteum

Ruminant Nutrition Symposium - Recent Developments in Trace Mineral Nutrition in Ruminants

191 Bioavailability of trace minerals in feeds. J. Spears*, *North Carolina State University, Raleigh.*

Limited research has evaluated trace mineral bioavailability from ruminant feedstuffs. Bioavailability of trace minerals from feedstuffs fed to ruminants may be affected by the chemical form and distribution of the

mineral within the feed. Selenium in feeds is largely in the form of selenomethionine, and this form of Se is more bioavailable in ruminants than inorganic Se from selenite. Forms of other trace minerals in feeds are less well defined. A portion of the Zn, Cu, and Mn in plants is present as various complexes or chelates. Iron can be found in plant materials as porphyrins, anionic complexes, and ferric hydroxide. Stud-

ies have indicated that a sizable portion (20% or greater) of the Zn, Cu, Fe and Mn in forages is associated with the plant cell wall. A prerequisite for trace mineral absorption is release of the mineral from feeds in a soluble form in the digestive tract. Based on in situ studies over 50 and 70% of the Zn and Cu, respectively, present in dried forages is solubilized in the rumen. In situ studies with grass silage indicate that over 90% of the total Zn and Cu present is released in the rumen. In vivo research with ruminants evaluating bioavailability of trace minerals from feedstuffs is sparse. Neathery et al. (1972) found similar absorption of ^{65}Zn in calves from ZnCl or from corn forage where labeled Zn was incorporated during plant growth. However, retention of ^{65}Zn 7 d post dosing was higher in a number of organs in calves dosed with ^{65}Zn labeled corn forage compared with ZnCl. Research is needed to further characterize the bioavailability of trace minerals from ruminant feedstuffs.

Key Words: Trace elements, Bioavailability, Ruminants

192 Effects of trace minerals on metabolic processes. T. Engle*, Colorado State University, Fort Collins.

Trace minerals have long been identified as essential components in the diets of domestic livestock species. Included in the category of essential trace minerals (or microminerals) are chromium, cobalt, copper, iodine, iron, manganese, molybdenum, nickel, selenium, and zinc. Numerous biochemical reactions have been identified that require trace minerals for proper function. It has been well documented that deficiencies of various trace minerals can result in metabolic diseases. However, the interactions between trace minerals and metabolic processes are extremely complex. Trace minerals have been identified as essential components for carbohydrate, lipid, protein, and vitamin metabolism, and have been shown to be involved in hormone production, immunity, and cellular homeostasis. In general, trace minerals function primarily as catalysts in enzyme systems within cells. Enzymes requiring metals for proper function can be classified into two categories: 1) metal activated enzymes and 2) metalloenzymes. Metal-activated enzymes may or may not have an absolute requirement for a metal; however the presence of a metal is typically required for optimizing enzyme activity. Metalloenzymes are enzymes that contain a tightly bound metal ion at or near the active site. The metal ions bound to metalloenzymes are actively involved in catalysis. Removal of the metal ion renders the enzyme non-functional. Enzymes involved in electron transport, bone metabolism, immune response, gene expression, nutrient metabolism, and protection of cells from oxidative stressors all have been shown to require certain trace elements for proper function. The intent of this review is to discuss the impact of trace minerals on metabolic processes in domestic livestock.

Key Words: Trace minerals, Metabolism, Enzymes

193 Water quality and trace minerals. C. Wright*¹ and J. Linn², ¹South Dakota State University, Brookings, ²University of Minnesota, St. Paul.

Water is the most essential nutrient for livestock and is critical for maintenance of numerous physiological functions. Under most conditions,

livestock will generally consume a large percentage of their water requirement by drinking. Water often contains substantial quantities of elements or compounds that could have a dramatic impact the trace mineral requirements of ruminants. It is possible that minerals in solution may be beneficial and contribute a significant portion of the animal's requirement. However, this area has received minimal attention in the literature to date. A more likely scenario is that minerals or compounds in water could function as an antagonist and create a secondary mineral deficiency. Survey data suggests that water can contain significant concentrations of calcium and magnesium (hardness), iron, manganese, and sulfate. Sulfate and iron concentrations are of particular importance in ruminant diets. Research has clearly demonstrated the negative effect of dietary sulfur, molybdenum, and iron on the copper status of ruminants. However, the effect of these compounds, in solution, has not been extensively investigated. Limited data from controlled research suggests that high-sulfate water will reduce the copper status of cattle not receiving a copper supplement. However, supplementation of beef heifers with 10 mg/kg copper, as CuSO_4 , has effectively increased liver copper stores in the presence of 1500 mg/kg sulfate. Field data has clearly shown that water sulfate concentrations in parts of the United States can exceed 10,000 mg/kg. Copper supplementation under these extreme conditions has not been investigated. To effectively formulate mineral supplementation strategies to address extremely high sulfate concentrations in water, it will be essential for researchers to determine what level and source of dietary copper is necessary to overcome the antagonism created by high-sulfate water, molybdenum and iron. Without question, more research is required to quantify the impact of minerals and compounds in water on the trace mineral requirements of livestock.

Key Words: Water, Trace minerals, Livestock

194 Increasing selenium in meat and milk through nutrition. J. Caton*, M. Ward, T. Lawler-Neville, M. Marchello, L. Reynolds, and G. Lardy, North Dakota State University, Fargo.

Selenium is an essential trace nutrient for normal growth and development in both livestock and humans. Both Se deficiency and excess has resulted in economic liabilities for livestock producers. Over the past 10 yr the image of Se has dramatically changed from a nutrient that is potentially dangerous and should be controlled within narrow ranges to one that has many potential health benefits when provided at supranutritional, but non-toxic, levels. This change can be attributed to recent work indicating that supranutritional levels of Se from yeast can reduce the combined incidence of lung, colorectal, and prostate cancers by as much as 50% in humans. These studies and others have spawned a large functional foods effort regarding high Se foods and human health benefits. This is of particular interest to the beef (and dairy) industries because beef is one of the largest sources of Se in typical diets consumed by North Americans. Beef has highly variable concentrations of Se that depend upon a variety of conditions. Recent research indicates that steers fed 60 to 70 Mg Se/d provided as high-Se wheat had greater ($P < 0.10$) muscle Se concentrations and similar intakes, gains, and efficiencies compared with control (7 to 12 Mg Se/d) and selenate (60 to 70 Mg Se/d) fed steers. Additionally carcass quality and consumer acceptability were similar among treatments. Interestingly, the Se content of harvested product was high enough to consider beef as a possible option

for providing supranutritional levels of Se in human diets. Similar data has recently been published regarding lamb and Se supplementation can increase Se delivery to the milk. Unpublished data from our laboratory indicates that supranutritional levels of Se alters vascularity in some tissues and spares fetal weight loss while increasing fetal muscle DNA concentrations when born by nutrient restricted dams. Current re-

search and interest in the area of Se-containing functional foods for health benefits highlights the need for assessing effects of dietary Se on both application and mechanistic components of tissue accretion, metabolism, and growth.

Key Words: Meat, Milk, Selenium

Nonruminant Nutrition - Proteins and Amino Acids

196 Comparison of commercial methionine sources in diets for 9 to 23-kg nursery pigs. R. L. Payne*, D. Hoehler, and M. Rademacher, *Degussa Corporation, Kennesaw, GA.*

Previous trials have reported that the bioefficacy of liquid MHA-FA is considerably lower than its Met-precursor concentration of 88% relative to DL-Met. The objective of this trial, conducted at the Swine Graphics Enterprises commercial research nursery, was to verify the results of previous bioefficacy research by testing if 65 parts DL-Met can replace 100 parts liquid MHA-FA. Six-hundred and sixteen mixed-sex crossbred pigs (PIC 1055 x PIC 280) with an average initial BW of 9 kg were randomly allotted based on sex and age to seven treatments. The treatments were a basal diet deficient in Met or the basal diet supplemented with three levels of DL-Met (0.03, 0.04, and 0.06%) or three levels of liquid MHA-FA (0.046, 0.062, and 0.092%). The Met-deficient basal diet contained 0.22% Met, 1.30% Lys, 0.85% Thr, 0.24% Trp, 0.70% Ile, and 3,440 kcal of ME per kg of diet and it was adequate in all other nutrients with the exception of Met. The basal diet was 69.9% corn, 3.4% soybean meal, 10% animal plasma and 10% whey. Each treatment was replicated 8 times (2 sexes x 4 pens each) with 11 pigs per replicate, and the trial lasted from d 21 to 42 post-weaning. The pigs were weaned on average on d 16 of age, and then from d 0 to 21 post-weaning, pigs were fed the same diet program adequate in all nutrients. Daily gain, ADFI, and feed:gain were improved ($P < 0.01$) when pigs were fed diets with DL-Met or liquid MHA-FA, regardless of supplementation level, compared with those fed the basal diet. Furthermore, ADG (367 g/d) and feed:gain (1.69) were greatest ($P < 0.01$) in pigs fed diets with the highest levels of Met supplementation (0.06% DL-Met and 0.092% liquid MHA-FA). Within each inclusion level pairing (0.03 vs. 0.046, 0.04 vs. 0.062, or 0.06 vs. 0.092), there were no differences in ADG, ADFI, or feed:gain ($P > 0.05$) when 65 parts DL-Met replaced 100 parts liquid MHA-FA in this trial. According to multi-linear regression analysis, liquid MHA-FA was 68.4% as efficient for ADG and 63.9% as efficient for feed:gain relative to DL-Met in this trial.

Key Words: Amino acid, Methionine, Nursery pig

197 Lysine requirement of pigs fed ractopamine HCl in a commercial facility. C. R. Neill*¹, S. S. Dritz¹, M. D. Tokach¹, J. L. Nelssen¹, R. D. Goodband¹, J. M. DeRouchey¹, and J. L. Usry², ¹*Kansas State University, Manhattan, KS*, ²*Ajinomoto Heartland LLC, Chicago, IL.*

A total of 2,834 gilts (PIC L337x C22) were used in three 21-d experiments in a commercial research barn to evaluate the effects of lysine

levels on pig growth and carcass performance when fed Ractopamine HCl (RAC). There were 7 replicates per treatment and 21 to 24 pigs per pen in all three experiments. In Exp. 1, 919 gilts (99.3 kg) were used to evaluate six TID lysine levels (0.75, 0.85, 0.95, 1.05, 1.15, 1.25%). All diets contained 6.75 ppm of RAC. As lysine level increased there was a linear increase ($P < 0.03$) in ADG (0.96, 0.98, 1.00, 1.04, 1.06, 1.01 kg) and G:F (0.36, 0.38, 0.38, 0.39, 0.40, 0.39). In Exp. 2 and 3, treatments included a control diet formulated to 0.65% TID lysine without RAC and diets containing 0.75, 0.85, 0.95, 1.05, and 1.15% TID lysine with 5 ppm RAC. There were 983 (98.6 kg) and 932 (102.6 kg) gilts in Exp. 2 and 3, respectively. All diets were corn-soybean meal based and contained high levels of synthetic amino acids (0.325% of L-lysine HCl with added threonine, methionine, and tryptophan) in Exp. 2, but only 0.075% L-lysine HCl in Exp. 3. As lysine level increased, there was a linear increase ($P < 0.05$) in ADG (0.84, 0.92, 0.94, 0.95, 1.05, 1.00 in Exp. 2; 0.88, 0.96, 1.00, 1.05, 1.03, 1.06 kg in Exp. 3.) and G:F (0.32, 0.36, 0.36, 0.37, 0.39, 0.39 in Exp. 2; 0.34, 0.37, 0.39, 0.41, 0.41, 0.42 in Exp. 3). Pigs fed RAC in Exp. 2 and 3 had increased ($P < 0.003$) ADG and G:F compared to pigs fed the control diet. For carcass data, percent lean and lean premium were linearly improved ($P = 0.03$) in Exp. 1 with increasing levels of TID lysine, but were not changed in Exp. 2. Average backfat and FFLI were linearly improved ($P < 0.03$) in Exp. 3 with increasing levels of TID lysine. These experiments suggest that pigs fed RAC require at least 0.95% or 26 g/d of TID lysine and at least 25 g of TID lysine/kg of gain.

Key Words: Lysine, Pigs, Ractopamine HCl

198 Effects of crystalline amino acids, ractopamine, and sodium bicarbonate on physiological pH in swine. K. Dorton*, T. Engle, R. Enns, and D. Anderson, *Colorado State University, Fort Collins.*

Eighteen barrows were utilized in a crossover design study to determine the effects of dietary inclusion of crystalline amino acids, ractopamine (RAC), and sodium bicarbonate (NaHCO_3) on urine and blood parameters indicating physiological pH in swine. This experiment was divided into 6 periods (P1 - P6): P1) 11 d adjustment phase; P2) 5 d baseline; P3) 4 d treatment; P4) 4 d treatment crossover; P5) 2 d NaHCO_3 addition; and P6) 2 d NaHCO_3 crossover. Treatments consisted of: T1) soybean meal (high protein diet; HP), T2) crystalline amino acids (low protein diet; CAA), T3) HP + RAC (20 ppm), or T4) CAA + RAC (20 ppm). Diets were formulated to meet lysine requirements for control and RAC-fed pigs (0.8% lysine for T1 and T2, 1.1% lysine for T3 and T4). During P5 and P6, treatments consisted of the above treatments with and without the addition of 2.5% NaHCO_3 . Diets were formulated to meet or exceed NRC (1998) requirements for energy, protein, vitamins, and minerals. During P3 and P4, barrows that received CAA had

lower urine pH ($P < 0.0001$) and blood urea nitrogen (BUN; $P < 0.0001$). Urine pH was greater ($P < 0.05$) and 24 hour urine volume ($P = 0.0003$) was lower in barrows that received RAC than controls. During P5 and P6, barrows that received CAA had a lower urine pH ($P = 0.0002$), blood pH ($P = 0.05$), BUN ($P < 0.0001$), and chloride concentrations ($P = 0.003$), and higher sodium concentrations ($P = 0.01$) and partial pressure carbon dioxide (PCO_2 ; $P < 0.02$) than barrows that received HP. Barrows that were supplemented with $NaHCO_3$ had a greater urine pH ($P = 0.004$), blood pH ($P = 0.01$), base excess ($P < 0.0001$), bicarbonate concentrations ($P < 0.0001$), TCO_2 ($P < 0.0001$), and Na concentrations ($P = 0.01$) than barrows that were not supplemented with $NaHCO_3$. These results indicate that the crystalline amino acid diets in both the control and RAC-fed pigs were acidogenic and that the addition of 2.5% $NaHCO_3$ reversed this acidogenesis. Ractopamine reduced urine volume but had minimal effects on acidogenesis.

Key Words: Swine, Diet, Acidogenesis

199 Comparison of crystalline amino acid additions to swine diets containing yellow dent and NutriDense corn. C. W. Hastad^{*1}, R. O. Gottlob¹, S. K. Linneen¹, M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, J. L. Nelssen¹, J. L. Snow², and C. M. Peter², ¹Kansas State University, Manhattan, ²ExSeed Genetics L.L.C., Owensboro, KY.

Three experiments were conducted to determine the amount of L-lysine HCl, L-threonine, and DL-methionine that could be used in diets with yellow dent (YD) or NutriDense (ND) corn before another amino acid became limiting. Treatments were arranged as factorials with L-Lysine HCl (0.15, 0.25, 0.35, or 0.45% in Exp 1; 0.15, 0.3, 0.45 in Exp 2 and 3) replacing soybean meal in diets with YD or ND corn. L-threonine and DL-methionine were added to maintain minimum ratios in all diets with less of these amino acids required in ND diets. In Exp 1, 360 pigs (15.8 kg) were used in a 16-d trial with 5 pigs/pen and 9 pens/treatment. Gain:feed was reduced (0.63, 0.63, 0.61, 0.59; quad, $P < 0.02$) as L-lysine HCl increased. Pigs fed ND corn had greater ($P < 0.01$) G:F than pigs fed YD corn (0.63 vs 0.60). In Exp 2, 1,189 pigs (39.8 kg) were used in a 28-d trial with 28 pigs/pen and 7 pens/treatment. Increasing L-lysine HCl linearly ($P < 0.01$) reduced ADG (867, 866, 817 g/d) and G:F (0.44, 0.43, 0.41) with no interaction ($P > 0.26$) between corn sources. Pigs fed ND corn had greater ($P < 0.05$) ADG (867 vs 833 g/d) and G:F (0.44 vs 0.43) than pigs fed YD corn. In Exp 3, 1,136 pigs (85.0 kg) were used in a 28-d trial with 27 pigs/pen and 7 pens/treatment. Increasing L-lysine HCl reduced ADG to a greater extent (interaction, $P < 0.03$) in YD (828, 772, 521 g/d) than in ND diets (822, 799, 629 g/d). A similar interaction ($P < 0.01$) was found with G:F reducing more quickly for YD (0.32, 0.31, 0.23) than ND diets (0.32, 0.31, 0.27) as the three amino acids were added. Because ND has higher tryptophan and other amino acids relative to lysine, higher levels of L-lysine HCl as well as lower amounts of L-threonine and DL-methionine can be used before another amino acid becomes limiting.

Key Words: Pigs, Corn hybrids, Amino acids

200 The optimal true ileal digestible lysine and sulfur amino acid requirement for nursery pigs between 10 and 20 kg. J. D. Schneider^{*1}, M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, J. L. Nelssen¹, J. M. DeRouchey¹, G. F. Yi², K. R. Perryman², and C. D.

Knight², ¹Kansas State University, Manhattan, ²Novus International Inc., St. Louis, MO.

An experiment involving 360 pigs (PIC, initial BW = 10.0 kg) was conducted to determine the appropriate true ileal digestible (TID) lysine and sulfur amino acid (SAA) requirement of nursery pigs, and consequently to determine the optimal TID SAA:lysine ratio. This trial was organized as a combination of two simultaneous experiments with one set of diets consisting of five increasing TID lysine levels (1.05, 1.15, 1.25, 1.35, and 1.45%) and the second set of diets consisting of five increasing TID SAA levels (0.61, 0.69, 0.76, 0.83, and 0.90%). Increasing TID SAA was satisfied by supplementing ALIMET[®] with 88% L-Met activity. The highest level of both lysine and SAA (1.45% and 0.90%, respectively) was combined as one diet and used for both the lysine and SAA titrations to give a total of 9 treatments. Pigs were randomly allotted to eight replications with five pigs per pen based on initial BW. ADG and G:F improved (quadratic, $P < 0.01$) with increasing TID lysine. The largest increase in ADG and G:F occurred as the TID lysine increased from 1.05 to 1.25%, respectively with little improvement thereafter. Increasing TID SAA increased (quadratic, $P < 0.01$) ADG and improved (quadratic, $P < 0.01$) G:F, and the largest improvement in ADG and G:F occurred as TID SAA increased from 0.61 to 0.76%. Interpretation of the response surface resulted in an estimate TID SAA to lysine ratio range of approximately 55 to 61%. [®]ALIMET is a trademark of Novus International, Inc. and is registered in the United States and other countries.)

Table 1.

Item	TID Lysine, %					SE	Linear	Quadratic
	1.05	1.15	1.25	1.35	1.45			
ADG, g	484	535	543	541	550	26.66	0.01	0.01
ADFI, g	763	794	778	758	768	16.47	0.45	0.28
Gain/Feed	0.64	0.69	0.71	0.72	0.73	0.008	0.01	0.01
Item	0.61	0.69	0.76	0.83	0.90	SE	Linear	Quadratic
ADG, g	510	537	563	558	550	26.66	0.01	0.01
ADFI, g	762	760	782	767	768	16.47	0.59	0.44
Gain/Feed	0.68	0.72	0.73	0.74	0.73	0.008	0.01	0.01
Gain/Feed	0.68	0.72	0.73	0.74	0.73	0.008	0.01	0.01

Key Words: Lysine, Sulfur amino acids, Nursery pigs

201 Determining the optimal lysine:calorie ratio for growth performance of 10 to 25 kg nursery pigs. J. D. Schneider^{*}, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey, Kansas State University, Manhattan.

Two studies were conducted to evaluate the effects of increasing dietary lysine and energy density on performance of PIC nursery pigs. Experiment 1 was organized as a combination of two simultaneous experiments with one set of diets consisting of five treatments with increasing true ileal digestible (TID) lysine (1.11, 1.19, 1.26, 1.34, and 1.42%) and the second set of diets consisting of five treatments with increasing energy density (2,956, 3,103, 3,251, 3,399, and 3,547 kcal/kg). The highest level of both lysine and energy density (1.42% and 3,547 kcal/kg, respectively) was combined as one diet for a total of 10 treatments. Pigs (BW = 9.3 kg) were randomly allotted to eight replications with

five pigs per pen. Increasing TID lysine linearly increased ($P < 0.01$) ADG and improved (linear, $P < 0.01$) feed efficiency. Increasing energy density had no effect on ADG, but decreased (linear, $P < 0.01$) ADFI, which resulted in a linear ($P < 0.01$) improvement in G/F. Regression analysis of the response surface was utilized to predict the optimal lysine:calorie ratio for ADG and G/F of 4.03 and 3.92 g lysine/Mcal ME, respectively, for the pigs used in this trial. In Exp 2, pigs (PIC, avg BW = 7.5 kg) were fed diets with two different energy densities (2.95 or 3.24 Mcal ME/kg) with TID lysine:calorie ratios ranging from approximately 3.5 to 4.5 g/Mcal ME. There was an energy density by TID lysine:calorie ratio interaction observed for G/F. Pigs fed the low energy

diets had the greatest G/F at a lysine:calorie ratio of 4.55. For pigs fed the high energy diets, G/F improved as the lysine:calorie ratio improved to 4.26 g of TID lysine/Mcal ME. There was an energy density by TID lysine:calorie ratio interaction observed for the grams of TID lysine required per kg of gain. Based on these results, the 7 to 18 kg PIC pigs in these facilities required 18 to 19 grams of TID lysine per kg of gain and because energy intake was lower with the lower energy diets pigs required a slightly higher lysine:calorie ratio.

Key Words: Lysine, Energy, Nursery pigs

Swine Extension - Swine Management

202 Assessment of educational needs for the Minnesota pork industry. M. Whitney*, *University of Minnesota Extension Service, Mankato, MN.*

A market research survey was conducted to assess educational needs and preferences of members of the Minnesota pork industry. A total of 1200 producers and allied industry were surveyed and data collected from April 8 to June 10, 2005. Participants were randomly selected from existing Minnesota Pork Board and University of Minnesota Extension Service mailing lists. A total of 369 producers and 230 allied industry members completed and returned surveys, resulting in an overall response rate of 54%. Response means were calculated for the entire survey and for producer and allied industry categories. Average age of respondents was 48 and 47 years, with over 20 years experience in the pork industry for 67% and 52% of producers and allied industry, respectively. Overall, respondents were likely to attend programs addressing animal health (81%), business/financial management (72%), marketing/economics (72%), housing/equipment (70%), manure management (70%), nutrition (69%), and odor management (63%). Respondents were most likely to obtain pork production-related information from magazines (90%) and newsletters (87%), in addition to veterinarians (83%) and other pork producers (81%). Additionally, 68% and 86% of producers and allied industry, respectively, were likely to obtain information from the internet. Seventy-one percent of respondents indicated they had attended at least one swine-related educational program over the past year. Program content (84%) and perceived value (58%) were considered very important when deciding whether to attend an educational event, followed by distance (42%) and length of program (25%). Preferred format to receive information was short publications (87%) and half-day seminars during the week (79%), followed by full-day workshops during the week (65%) and on-line courses (54%). These results indicate that producers and allied industry in Minnesota have educational needs in a variety of topic areas, and that time involved to obtain information is the major factor involved when obtaining pork production information.

Key Words: Education, Pigs, Survey

203 PorkBridge®: An on-farm delivered extension program. M. Brumm*¹, D. Levis^{1,2}, and D. Ricker², ¹*University of Nebraska, Concord,* ²*The Ohio State University, Columbus.*

While decision makers in swine production systems often attend educational events, employees and contract growers often have few opportunities for continuing education. PorkBridge was designed to deliver educational opportunities to the farm on a repeated basis, with the target audience being those people responsible for the daily care of grow-finish pigs. Participants in the program received a CD in the mail 1 week prior to each bi-monthly session which contained a MSPowerpoint (run-time version) of the speaker's presentation and supporting material. Presenters were located at the U of Nebraska, Iowa State U, Purdue U, South Dakota State U and the U of Missouri. There were 6 sessions over a 1 yr period. At noon local time participants called a toll-free telephone number. A moderator introduced the topic and presenter. For 45 minutes the presenter discussed their slides as attendees followed along on their computers. There were opportunities to ask questions during the presentation and in a Q and A session at the end. The number of participants per site ranged from 1 to more than 8, although the \$100 enrollment fee for all 6 sessions was based on the number of incoming telephone lines, not the number of attendees. Participants included employees, owners, veterinarians, consultants, lenders, and contract growers. At the conclusion of the sixth session, participants were surveyed about the program. On a 1 to 5 scale, with 5 being the best, participantâ™™s ranked convenience at 4.54 and the value for the time invested at 4.54. The method of program delivery was rated at 4.17 and plans to participate in future PorkBridge efforts were rated at 4.23. The educational level of the material presented was rated at 4.31, suggesting the program content was matched to the participant's expectations. A negative aspect cited dealt with reliability of telephone connections. The most often cited positive aspect of the program was "Education without travel". In conclusion, PorkBridge is an effective method to provide educational information directly to animal caregivers at the farm level and is a method to make continuing education available to a wider variety of people involved in the pork industry.

Key Words: Extension, Swine

204 Effect of weaning age on nursery pig performance. A. L. Smith*, K. J. Stalder, T. V. Serenius, T. J. Baas, and J. W. Mabry, *Iowa State University, Ames*.

The objective of this study was to quantify the effects of weaning age on nursery pig performance. The study utilized Danbred N.A. (Columbus, NE) barrows and gilts (n=2,467) from a commercial maternal line multiplication herd. Litters were randomly assigned at birth to either a 15 d average (pigs weaned at 14, 15, or 16 d of age) or a 20 d average (pigs weaned at 19, 20, or 21 d of age) weaning age group and litters within weaning age group were randomly assigned to pens so that litters and pens were not confounded. Twenty-eight pigs (mixed sexes) were housed in each 2.44 x 3.05 m nursery pen. Pigs were only removed from test pens due to death or if a non-ambulatory condition existed. Feed delivery was recorded on a pen basis with each pig receiving 1.25 kg of a 23% CP pellet, 6.14 kg of a 21.2% CP diet, 12.57 kg of a 18% CP diet and the remainder a 17.3% CP diet. Statistical analyses were conducted using the PROC MIXED procedure of SAS (Cary, NC). Fixed effects of weaning age group, pen, and parity of dam were included in the model

for ADG. When the fixed effects were a significant ($P < 0.05$) source of variation, differences between fixed effects were analyzed using the PDIF option of SAS. Pigs weaned at a 20 d average age had a greater ($P < 0.01$) nursery ADG when compared to pigs weaned at a 15 d average age (0.79 vs. 0.72 kg/d). Fewer ($P < 0.03$) pigs were removed from test (2.07, 1.01 %) when pigs were weaned at a 20 d average age compared to pigs weaned at a 15 d average age. The models for ADFI and G:F were evaluated on a pen basis and were analyzed using a model with fixed effects of pen and weaning age group. Pigs weaned at a 20 d average age had a 0.06 kg/d greater ADFI when compared to pigs weaned at a 15 d average age. Pigs weaned at a 20 d average age were 2.88 kg heavier in comparison to pigs weaned at a 15 d average age at the end of the nursery phase. No ($P < 0.89$) differences in G:F were observed between pigs weaned at a 15 or 20 d average age. Weaning pigs at a 20 d average age may prove advantageous in commercial operations because of improvements in nursery performance and in pig weight at the end of the nursery phase.

Key Words: Swine, Weaning age, Growth performance

Physiology - Topics in Ovarian Physiology - Young Investigators' Perspective

205 Ovulatory response of beef heifers to GnRH: Effect of stage of the estrous cycle. J. A. Atkins*, D. C. Busch, J. F. Bader, D. J. Schafer, M. C. Lucy, D. J. Patterson, and M. F. Smith, *University of Missouri, Columbia*.

The objective was to examine the effects of ovulation or failure to ovulate to the first GnRH injection (GnRH-1) in a CO-Synch protocol (GnRH on d -9, prostaglandin F_{2A} (PGF) on d -2, and GnRH with fixed-time AI on d 0) on size and ovulatory response of the dominant follicle to the second GnRH injection (GnRH-2). In addition, the effect of dominant follicle size on serum progesterone concentrations following ovulation was characterized. Beef heifers (n=63) were allotted by age, weight, and breed to one of five treatment groups (n=10 to 14). Treatment groups were defined by the day of the estrous cycle (d 2, d 5, d 10, d 15, and d 18) when GnRH-1 was administered and represented different stages of a follicular wave (no dominant follicle, small first wave dominant follicle, large first wave dominant follicle, second wave dominant follicle, and large second wave dominant follicle, respectively). Day of the estrous cycle at GnRH-1 affected ($^{abc}P=0.05$) ovulatory response to GnRH-1 with the highest ovulation rate occurring on d 5 (12/13)^a, followed by d 15 (9/13)^{ab}, 10 (4/13)^{bc}, 18 (2/10)^c, and 2 (0/14)^c. Ovulatory response to GnRH-2 was higher ($P < 0.05$) in heifers that received GnRH-1 on d 2 (13/14), 5 (12/13), and 10 (12/13) compared to d 15 (2/13) or 18 (2/10). Ovulation to GnRH-1 did not affect ovulatory response to GnRH-2 or size of the dominant follicle at GnRH-2. There was a higher frequency of luteolysis and estrus before PGF in heifers that received GnRH-1 on d 15 and 18 compared to heifers that received GnRH-1 on d 2, 5, or 10 ($P < 0.01$). The rate of increase in serum concentrations of progesterone after insemination (d 2 to 12) was higher ($P=0.05$) in heifers that ovulated large (≥ 11 mm) compared to small (< 11 mm) dominant follicles. In summary, ovulatory response to GnRH-2 was greatest when GnRH-1 was administered on d 2, 5 or 10 compared to d 15 or 18. Furthermore, GnRH-induced ovulation of small (< 11 mm) dominant follicles resulted in a diminished rate of increase in progesterone following insemination compared to large (≥ 11 mm) follicles.

Key Words: GnRH, Follicle, Ovulation

206 Reducing variability in the age and size of the ovulatory follicle may enhance fertility following Ovsynch in lactating dairy cows. N. M. Bello*, J. P. Steibel, and J. R. Pursley, *Michigan State University, East Lansing*.

Low fertility remains the leading reason for poor reproductive performance in dairy cows. The fertile development of the ovulatory follicle is essential for conception and maintenance of pregnancy. Ovsynch allows for synchronized development of the ovulatory follicle and ovulation, but size of the ovulatory follicle at the time of the GnRH induced LH surge is variable. Data from our lab and others indicate that inducing ovulation in cows with follicles < 12 mm or > 18 mm in antral diameter reduces % of cows diagnosed pregnant. Recent data indicate that as many as 1/3 of cows ovulate follicles < 12 mm antral diameter following Ovsynch. Our central hypothesis is that greater hormonal control of the emergence and subsequent ovulation of a fully mature ovulatory follicle will allow for a greater chance of conception. Three studies are designed to test this hypothesis. Our rationale for these studies is that their successful completion would provide a new synchronization program for lactating dairy cows that allows for maximal fertility following timed-AI. Preliminary data indicate that it is critical to ovulate a dominant follicle (DF) following the 1st injection of GnRH in the Ovsynch program. Doing so allowed for the synchronous development of the ovulatory follicle with significantly less variation in peak antral diameter. If a DF did not ovulate following the 1st GnRH of Ovsynch, the existing follicles were likely in the first 3 to 4 d of the wave and the subsequent variation in size and age of the ovulatory follicle was increased. This presentation will discuss the strategies used to maximize the number of cows that ovulate a DF to the 1st GnRH of Ovsynch. In summary, ovarian follicular development varies in cows treated with Ovsynch and this variability is associated with low fertility. Greater control of the subsequent ovulatory follicle will be tested to determine if variation in age, size and maturational status can be decreased, and if this decrease in variation may lead to enhanced fertility in lactating dairy cows.

Key Words: Fertility, Dairy cow, Follicle

207 The influence of preovulatory estradiol concentrations on uterine function in beef cattle. G. A. Bridges*, M. L. Mussard, D. E. Grum, L. A. Helsler, C. L. Gasser, D. M. Dauch, J. L. Pate, and M. L. Day, *The Ohio State University, Columbus*.

Multiple experiments conducted in our laboratory have demonstrated that fertility is reduced in cattle that are induced to ovulate immature follicles and suggest that this infertility is due to an impaired ability of the uterus to support embryonic development. Collectively, our research also suggests that ovulatory follicle diameter is a marginal predictor of maturity and that preovulatory estradiol concentration during proestrus (the interval from luteolysis to the LH surge) may serve as a more accurate indicator of follicle maturity. Thus, the focus of our current research is to evaluate functional differences in the uterus' capacity to support conceptus development in cows that are induced to ovulate follicles of differing maturity. We hypothesize that a reduction in preovulatory estradiol concentrations leads to a uterine environment that is deficient in its ability to support conceptus growth and maintain pregnancy. To investigate this hypothesis we have developed an animal model in which ovulation of follicles of similar age and size is induced following either a short (1.2-1.5 d) or long (2.2-2.5 d) period of proestrus. With this model, animals that differ in preovulatory estradiol concentrations can be compared. We have demonstrated that fertility is reduced, luteal function is compromised in some animals, and uterine mRNA concentrations of both oxytocin receptor and cyclooxygenase-2 are increased on day 5 of the estrous cycle in cows with decreased preovulatory estradiol. Other studies have been initiated to determine the influence of preovulatory estradiol concentrations on conceptus growth and interferon tau production, the expression of several uterine genes, and the steroidogenic capacity of the CL 15 days after induced ovulation. In summary, altered uterine function, as a result of decreased preovulatory estradiol concentrations, may be responsible for the decreased fertility that results when immature follicles are ovulated.

Key Words: Cattle, Estradiol, Uterus

208 Effect of GnRH after timed AI on conception rates in lactating dairy cows. A. Cunha*, A. Souza, E. Silva, D. Brusveen, C. Silva, J. Powell, J. Guenther, and M. Wiltbank, *University of Wisconsin, Madison*.

Two experiments were performed to evaluate if GnRH treatment after timed AI (TAI) increased conception rates (CR) in high producing dairy cows. In experiment 1, lactating Holstein cows (n=821) received Ovsynch (GnRH-7d-PGF2? -56h-GnRH-16h-TAI) and 7 days after TAI cows were assigned to one of two groups in a CRD design 1) treatment: 100Î¼g GnRH on days 7 and 14 after TAI; 2) control: no treatment. Overall CR and pregnancy loss (PL) were not different (P>0.10) between GnRH-treated and control cows 41.6% (n=404), 41.2% (n=417) and 11.0% (n=148), 7.0% (n=144), respectively. More (P<0.01) cows ovulated after GnRH on day 7 (79%, n=354) than day 14 (47%, n=311). Ovulation to GnRH on day 14 did not alter (P>0.10) CR. However, cows that ovulated after GnRH on Day 7 had better CR (37.5%, n=264) than GnRH-treated cows that did not ovulate (24.7%; P<0.01) or control cows (34.4%, n=389; P<0.05). In experiment 2, 702 lactating Holstein cows underwent Cosynch (GnRH-7d-PGF2? -48h-GnRH+AI) and 17 days after TAI cows were assigned to one of two groups 1) treatment: 100 Î¼g GnRH on day 17 after TAI; 2) control no treatment. Pregnancy diagnosis was performed by ultrasound on day 33 and 54

after TAI. Overall CR and PL were not different (P>0.10) between GnRH-treated and control cows 34.0% (n=350), 31.7% (n=341) and 19.0% (n=116), 12.6% (n=103), respectively. Nevertheless, treatment with GnRH on Day 17 delayed (P<0.05) luteolysis based on ultrasound evaluations of a subset of these cows (n=165). Experiment 2 was replicated on another commercial dairy farm (n=271). Again, the overall CR was not different (P>0.10) between GnRH-treated (35.5%, n=138) and control cows (35.3%, n=133). In conclusion, GnRH treatments on days 7, 14, or 17 failed to increase CR in cows treated with TAI protocols. However, lack of ovulation to GnRH on day 7 after AI allowed selection of a group of less fertile cows and this finding may be relevant to understanding the factors reducing conception rates in lactating dairy cows.

Key Words: GnRH, Conception rate, Dairy cows

209 Administration of GnRH 5 days after first timed artificial insemination improves fertility in anovular lactating dairy cows.

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Differences in progesterone concentration between pregnant and non-pregnant cows have been reported as early as 5 d after AI. To test the hypothesis that increased progesterone after TAI would increase fertility, lactating Holstein cows were submitted to one of three post-insemination treatments in two experiments [Experiment 1; 1) no treatment (C; n = 226), 2) CIDR from 5 to 12 d after TAI (CIDR; n = 220), and 3) 100 Mg GnRH 5 d after TAI (G5; n = 228)] [Experiment 2; 1) C (n = 163), 2) G5 (n = 158), or 100Mg GnRH 7 d after TAI (G7; n = 164)]. Only cows receiving their first postpartum (PP) timed AI (TAI) after a Presynch/Ovsynch protocol were enrolled for study [25 mg PGFA (PG) and 100 Mg GnRH (G) as follows: PG (32±3 and 46±3 d PP); G (60±3 d PP); PG (67±3 d PP); G+TAI (69±3 d PP)]. At the first G of Ovsynch cows were examined via ultrasound for the presence or absence of a CL = 10 mm, and cows lacking a CL were classified as anovular. There were no differences among treatments in fertility at 61 d for Experiments 1 (C = 45.5; CIDR = 42.4; G5 = 50.9%; P = 0.148) or 2 (C = 46.3; G5 = 46.5; G7 = 46.9%; P = 0.523). When data for C (n = 380) and G5 (n = 383) cows from Experiments 1 and 2 were combined and analyzed, G5 cows tended (P < 0.09) to have greater fertility 61 d after TAI (49.1 vs. 45.8%). Moreover, there was a treatment by cyclicity interaction in which anovular cows treated with G5 had greater (P < 0.05) fertility than non treated anovular cows (45.5 vs. 31.1%), whereas fertility for cycling cows did not differ (50.7 vs. 51.5%). Based on this treatment by cyclicity status interaction, we have rejected our original hypothesis and are now testing the hypothesis that improved fertility in anovular cows treated with GnRH 5 d after first timed AI is related to subsequent changes in follicular dynamics.

Key Words: Anovulation, Dairy cow, GnRH

210 Vascular development within the perinatal rat ovary is not exclusively regulated through Vascular Endothelial Growth Factor Receptor-2 (VEGFR-2) in rat organ ovarian cultures. R.

Ten Broeck*, D. Clopton, R. Bott, M. Baltes, and A. Cupp, *University of Nebraska, Lincoln*.

Our laboratory is determining the effects of angiogenic factors, such as Vascular Endothelial Growth Factor (VEGF), on ovarian morphogenesis and follicle progression. Previous research in our laboratory established that inhibition of VEGF signal transduction through both VEGF receptors, VEGFR-1/Flt-1 or VEGFR-2/Flk-1/KDR, inhibited vascular development (by 90%) and primordial follicle progression to the preantral stage in the perinatal rat ovary. Therefore, we hypothesized that perinatal follicular progression was regulated by VEGF through VEGFR-2. An organ culture system was used to mimic an *in vivo* environment for the development of follicles on the ovary. Postnatal d 3 and 4 rat ovaries were cultured with V1, an inhibitor to VEGF, blocking the binding of VEGF to VEGFR-2 for 14 days. Two treatment doses of V1 were administered, a 15 μ M dose (n=5 pairs) and a 30 μ M dose (n=12 pairs). After culture, whole mount immunohistochemistry was conducted to stain basement membrane of follicles (laminin A-1) and vasculature within the ovaries (PECAM). Preliminary results demonstrate that there was no difference in vasculature density between the control ovaries and either dose of V1 ($P > 0.05$). Thus, VEGF may act through both VEGFR-2 and VEGFR-1 to establish vascular development. Alternatively, other factors may be compensating for VEGF's actions through VEGFR-2 in our organ culture system. Further research in our lab is being conducted to determine effects on follicle progression after treatment with V1 in the organ culture system.

Key Words: VEGF, Follicle, Angiogenesis

211 Utilization of Vascular Endothelial Growth Factor Receptor 2 (VEGFR-2)/Lac-Z mice to elucidate the role of Vascular Endothelial Growth Factor (VEGF) on vascular development during gonadal morphogenesis. M. Baltes*, R. Bott, D. Clopton, and A. Cupp, *University of Nebraska, Lincoln*.

Disruptions in normal gonadal development can lead to impaired fertility later in life. Vascular development plays a critical role in testis and ovarian morphogenesis. Previous research in our lab has shown that inhibiting vascular development, through inhibition of VEGF signaling, can inhibit normal cord formation in the testis and prevent progression of primordial follicles to the preantral stage in the ovary. Our laboratory obtained transgenic mice containing the Vascular Endothelial Growth Factor Receptor-2 (VEGFR-2/KDR/Flk-1) gene driving Lac-Z. VEGFR-2 is expressed on endothelial cells; therefore, our intent was to determine the pattern of vascular development in both gonads and the potential role of VEGF in this process. Whole mount immunohistochemistry for Lac-Z was performed on the testis and ovary at different developmental stages to determine the expression of VEGFR-2. VEGFR-2 was expressed in endothelial cells migrating from the testis at embryonic day 11 (E11; E0= plug date) and surrounded seminiferous cords at E12 and thereafter. In addition to expression in vasculature within the cords, VEGFR-2 was expressed in subsets of germ cells at E16-E17, postnatal day 20 (P20), P30 and P60. VEGFR-2 was expressed in the developing ovary from E11 through E13 with a higher expression from E11 to E12. Expression of VEGFR-2 is maintained with high intensity in the mesonephric vessels at E17. At E18, VEGFR-2 staining was present around oocyte nests and in close apposition to primordial follicles that are transitioning at P0 and P3 to primary follicles. VEGFR-2/Lac-Z transgenic mice are useful models to determine expression of VEGFR-2 and its role during gonadal morphogenesis.

Key Words: VEGF, Lac-Z, Ovary

212 Expression of anti-angiogenic Vascular Endothelial Growth Factor (VEGF) 164b during rat ovarian morphogenesis: Potential regulation of VEGF angiogenic isoform function. R. A. Longfellow*, R. M. Pohlmann, M. M. Baltes, D. T. Clopton, and A. S. Cupp, *University of Nebraska, Lincoln*.

The development of new blood vessels (neovascularization) is essential for growth of tissue, as well as maturation of follicles within the ovary. Data from our laboratory has determined that inhibition of VEGF signal transduction inhibits vascular development and primordial follicle progression in perinatal rat ovaries. Multiple isoforms of VEGF are generated from alternative splicing of eight exons in the *VegfA* gene. In addition to five angiogenic isoforms, in the human, an anti-angiogenic isoform VEGF 165b has been identified. VEGF 165b acts to inhibit VEGF 165 by competing for binding to the VEGF receptors. Our laboratory has subcloned and sequenced rat VEGF 164b (one less amino acid than humans) in the embryonic testis and ovary. Because angiogenesis is critical to ovarian development, it is our hypothesis that the function of VEGF 164b (anti-angiogenic isoform) also plays a key role in regulation of vascular development within the ovary. Expression of VEGF 164b within the rat ovary was examined using conventional PCR at time points ranging from embryonic day 13 to postnatal day 10. Thus far, our expression data has shown VEGF 164b expressed at each time point tested. This is interesting, because the expression patterns of VEGF 164b appear to be more regulated in the embryonic and perinatal testis at the same stages. Further quantification of the VEGF 164b isoforms is being conducted to determine its expression with real-time PCR. It is our expectation that by examining the expression patterns and function of VEGF 164b in ovarian organ cultures experiments, we will in turn better understand its role in ovarian vascular development.

Key Words: VEGF, Ovarian development, Isoform

213 Development of methodology for induction of follicular selection, estrus, and ovulation in swine using purified porcine FSH. S. M. Breen* and R. V. Knox, *University of Illinois, Urbana*.

Control of ovarian function provides advantages for controlling estrus, ovulation and for production of oocytes and embryos. Inconsistency in these response variables has been a concern when using PMSG and hCG. In many species, porcine FSH (pFSH) is now the choice for improved efficacy yet little data is available to indicate its value for use in pigs. Preliminary data suggests that semi-purified pFSH may be a viable alternative to PMSG/hCG. Therefore, the objectives of the proposed studies are to develop pFSH administration methodology for induction of synchronized follicular development, estrus, ovulation, and production of high quality oocytes and embryos. Experiment 1 will determine the effect of 5 different doses of pFSH in prepubertal gilts. FSH will be given in 6 s.c. injections at 8-h intervals. The effects of dose on follicle size and numbers will be determined by daily ultrasound for 7 days. During the same, period blood samples will be collected to determine concentrations of progesterone, estradiol, androstenedione, and FSH. In a sub-population of gilts, ovaries will be collected at day 3 for histological assessment of follicle populations, follicular aromatase and atresia. Some of the remaining gilts will be used to assess estrus expression, ovulation, and oocyte quality immediately following ovulation. In the final group, gilts will be inseminated and the number and quality of embryos at 56 hours. Experiment 2 will determine the minimum injection frequency needed when using a slow release substance

for pFSH on the same response variables as experiment 1. This experiment will involve the administration of pFSH doses (3 levels) and num-

ber of injections (2 levels) in a slow release substance. One of the doses will be the optimal dose determined from experiment 1.

Key Words: Gilts, FSH, Ovulation

Ruminant Nutrition - Forages and Grazing

216 Winter grazing systems for gestating ewes. S. Loerch*, D. Clevenger, P. Tirabasso, and G. Lowe, *The Ohio State University, Wooster.*

Effects of four winter feeding systems on ewe performance were determined. The trial was conducted from January to March (70 d) in 2002, 2003, and 2004. The treatments investigated were: 1) low density corn; 2) high density corn; 3) fescue regrowth; and 4) round baled hay. Each treatment had two replicates per year. An average of 108 Hampshire × Dorset ewes (avg BW = 91 kg) in early gestation were randomly allotted to the replicates each year. The low and high density corn treatments were planted to achieve densities of 54,000 and 92,000 corn plants/ha, respectively. Each replicate field was 0.4 ha and electric fence was used to divide each field into 10 paddocks for strip-grazing. Fescue pastures were 0.9 ha each and were also strip grazed. Fescue hay was offered ad libitum in drylot for the round baled hay replicates. Data were analyzed according to the PROC GLM procedures of SAS and treatment means were separated by PDIF. Ewes grazing low density corn had the greatest BW increase (10.9 kg), those grazing high density corn or fed hay were intermediate (7.9 and 6.2 kg, respectively) and ewes grazing fescue lost 1.6 kg ($P < 0.01$). Ewes fed round baled hay consumed an average of 2.2 kg of DM/ewe/d. Ewe grazing days for the low and high density corn (2921 and 2945 ewe d/ha, respectively) were greater ($P < 0.01$) than ewe grazing days for fescue (591 ewe d/ha). Need for emergency supplemental feed (whole shelled corn) resulted in a treatment × year interaction ($P < 0.01$). For the corn grazing treatments, emergency feed was only needed in 2004 (7 d at 0.75 kg/ewe/d). Ewes grazing fescue required 0.45 kg of whole shelled corn/ewe/d for 40 (2003) or 50 d (2004). Ewes fed baled hay required 0.4 kg of whole shelled corn/ewe/d for 11 (2002), 26 (2003), and 38 d (2004). Feed costs/ewe/d were \$0.13 for both corn grazing treatments, \$0.17 for fescue grazing and \$0.24 for hay feeding. Winter grazing standing corn or stockpiled fescue was an effective and economic winter feeding strategy for gestating ewes.

Key Words: Ewes, Grazing, Corn

217 Effects of annual versus perennial grass pastures on animal carrying capacity and performance of lactating ewes. D. Clevenger*, S. Loerch, G. Lowe, and P. Tirabasso, *The Ohio State University, Wooster.*

Three grazing systems were evaluated. The first system (Annuals) involved grazing winter rye and Italian ryegrass (seeded the previous spring) from mid-March to early May; spring seeded oats from early May to mid-June; and spring seeded Italian ryegrass from mid-June until mid-July. Each 0.3 ha forage paddock was represented by two replicates, each containing 16 ewes (1.2 total ha/16 ewes). In the second system, ewes strip-grazed permanent orchardgrass pasture (Strip-Graze). Replicate 0.6 ha orchardgrass pastures with 8 ewes/replicate were each divided into eight paddocks for daily rotations. In the third

system, replicate 0.6 ha orchardgrass pastures were continuously grazed by eight ewes/replicate (Continuous-Graze). The experiment was conducted over three consecutive years. Ewes lambed on pasture from late-April to mid-May and reared their lambs on pasture until weaning at approximately 65 days of age (mid-July). Ewes were Hampshire × Dorset with an average BW of 94 kg. During lactation, ewes grazing Annuals lost less ($P < 0.01$) weight than Strip- and Continuous-Grazed ewes (ADG: -85, -166, and -214 g/d, respectively). Lamb ADG was greater ($P < 0.01$) for Annual and Continuous-Grazed than for Strip-Grazed (296 and 287 vs 250 g/d, respectively). Lamb gain/ha was greatest for Continuous-Grazed (350 kg), lowest for Annuals (206 kg), and intermediate for Strip-Grazed (297 kg; $P < 0.01$). Ewe grazing days/ha was greatest for Strip-Grazed (1318), lowest for Annuals (579), and intermediate for Continuous-Grazed (1057; $P < 0.01$). Forage NDF averaged 61% and was not affected ($P > 0.05$) by grazing system. Forage CP% was greater ($P < 0.01$) for Annuals than Strip- or Continuous-Grazed (20.2 vs 17.9 and 17.9%, respectively). The use of annual grasses allows opportunity for double cropping and may reduce permanent pasture acreage needed to support a sheep enterprise. However, individual animal performance and carrying capacity/ha was lower for annual grasses than for permanent orchardgrass pastures.

Key Words: Sheep, Grazing, Annual grasses

218 Dried distillers grains supplementation to calves grazing corn residue. K. Gustad*, T. Klopfenstein, G. Erickson, J. MacDonald, K. Vander Pol, and M. Greenquist, *University of Nebraska, Lincoln.*

The objectives of this experiment were to determine the effects of incremental dried distillers grains with solubles (DDGS) supplementation to calves grazing corn residue on ADG and to predict the effect of supplementation on forage intake. One hundred and twenty steers (233 ± 17 kg) were stratified by weight and assigned randomly to incremental levels of DDGS treatments. Treatments included .68, 1.14, 1.59, 2.05, 2.5, and 2.95 kg DDGS/head-1•d-1 adjusted to a percent of body weight (.29, .49, .69, .88, 1.08, and 1.27% respectively.) Steers were limit fed for 5 d and weighed over 3 d at the beginning and end of trial, and were weighed on consecutive d biweekly to adjust the amount of DDGS offered. All steers were individually fed the supplement daily using Calan[®] electronic gates. Thirty calves were selected as a control group and fed a diet of 70.9% brome hay and 29.1% sorghum silage with DDGS treatments assigned randomly within the hay diet for direct intake measurement. The remaining 90 calves grazed 36.44 ha of corn residue for 95 d; these calves were gathered daily for supplementation. Corn residue diet samples were collected biweekly using ruminally cannulated heifers and IVDMD was determined. In grazing calves, ADG increase quadratically ($P < .001$) with increasing amounts of DDGS with a range of 0.41 kg at the lowest level to 0.82 at the highest supplement level. Calves fed hay had ADG ranging from 0.86 to 1.09 kg with in-

creasing DDGS. Forage intake in hay fed calves decreased linearly ($P < .001$) with increasing DDGS supplementation; specifically, 5.14 kg at the lowest level to 3.77 kg at the high supplemental level. A similar decrease in intake is expected in the calves grazing corn residue. These data can be used to predict DDGS supplementation level needed to achieve desired gains and resulting corn residue intake.

Key Words: Corn residue, Forage intake, Dried distillers grains

219 Comparison of in vivo digestibility to in vitro digestibility of five forages fed to steers. B. G Geisert*, T. J. Klopfenstein, D. C. Adams, and J. C. MacDonald, *University of Nebraska, Lincoln*.

The objective was to determine the in vivo digestibility of 5 forages fed to beef cattle and to develop standards to estimate in vivo values from IVDMD. Eight cross-bred yearling steers ($BW = 323 \pm 29$ kg), in a Latin Square design, were fed 5 hays (fed chopped), varying in quality including mature alfalfa (MA), immature alfalfa (IA), mature brome (MB), immature brome (IB) and a warm season prairie (PR). Steers were adapted to treatment for 16 d followed by a 5 d collection period. During the first 10 d of adaptation period steers were fed ad-lib and then were restricted

to 90% of ad-lib intake. Diet samples were collected daily on d 12 through d 21 and analyzed for DM, OM, NDF, IVDMD, and CP. Total feces were collected and analyzed for DM, OM, NDF, and CP. Forages contained 7.9, 13.0, 13.7, 14.7, and 16.0% CP and 68.3, 69.6, 66.7, 67.9, and 60.5% NDF for PR, MB, IB, MA, and IA, respectively. As quality of the forage increased, DMI increased ($P < 0.01$) (5.67, 5.95, 6.12, 6.76, and 7.23 kg/d for diets PR, MB, IB, MA, and IA, respectively). DMD and NDFD also differed ($P < 0.01$) with IA (DMD=60.6% NDFD=53.7%) and was more digestible than PR, MB, and MA (DMD=50.8%, NDFD=46.4%). In vivo DMD was 50.2, 51.2, 50.9, 56.4, and 60.6% for diets PR, MB, IB, MA, and IA, respectively. The averages of 6 IVDMD runs were 54.5, 52.8, 58.6, 60.1 and 67.1% for PR, MB, IB, MA, and IA, respectively. When IVDMD from all runs was regressed against in vivo DMD there was a high correlation ($R^2 = 0.89$) and no differences between slopes of individual runs ($P = 0.99$). IVDMD can be adjusted to in vivo results by regression. The adjustment for these data ranged from 0.10 to 13.3 percentage units, with an overall average adjustment of 5.3. Results from this study suggest that IVDMD values may not accurately reflect in vivo digestibility, however, by including these five hay samples as standards in IVDMD analysis, regression equations can be applied to determine in vivo digestibility values of forage samples.

Key Words: Digestibility, Cattle, Forage

Beef Extension

220 Performance variation of ISO 11785 radio frequency cattle transponders and interrogators. A. Bryant*, D. Blasi, B. Barnhardt, M. Epp, and S. Glaenger, *Kansas State University, Manhattan*.

This study was conducted to evaluate the performance of ISO 11785 radio frequency identification (RFID) cattle ear transponders and interrogators under ideal laboratory conditions. Transponder and interrogator manufacturer identities are masked to avoid unintentional conclusions drawn on any particular transponder or interrogator at this stage of the US National Animal Identification System (US-NAIS) proposed plan. Eight commercially available transponder designs were evaluated ($n = 390$) and included the half-duplex (designs B and E) and full-duplex (designs A, C, D, F, G, and H) air interface technologies. Performance parameters of interest for the transponder designs were tensile strength, tamper evidence characteristics, sensitivity (mV), amplitude (mV), as well as the average read range (cm) from the interrogator. Sensitivity and amplitude were measured using an oscilloscope (Tektronix 2213) and function generator (Hewlett Packard 3314A). Three fixed antenna stationary interrogators were used (X, Y, and Z) to determine the variability between interrogator read ranges of each manufacturer. Tensile strength parameters for the transponder designs differed ($P < 0.05$) with designs G and C requiring the most force to break apart. Transponder F was the only design that displayed no tamper evident characteristics. Transponder designs D, G, and C required the least amount of generator output at 134.2 KHz to achieve the transmission of valid data whereas transponder designs A, B, and E emitted the greatest energy signal when activated. Average read ranges differed ($P < 0.05$) between all eight transponder designs and there were significant differences ($P < 0.05$) in performance ranges between each of the three interrogators. Performance variation in transponders and interrogators exists due to differences in material makeup (die and copper) and design characteristics.

The results of this study supports the need for minimum performance standards for ISO 11785 RFID technology as it applies to the US-NAIS.

Key Words: RFID, Transponder, Read range

221 Comparison of feed efficiency rankings of beef heifer calves fed low and high energy diets. J. A. Christopher*, T. T. Marston, J. M. Bormann, R. M. Breiner, and D. A. Llewellyn, *Kansas State University, Manhattan*.

Angus crossbred heifer calves ($n = 26$, starting $BW = 277.6$ kg) were used to determine if energy density of the diet affects their ranking in feed efficiency. Feed efficiency was calculated as: 1) the ratio of feed intake to animal body weight gain (FGR), 2) relative feed intake as the difference between actual feed intake and predicted feed intake (NRC, 2000) (RFI), or 3) residual feed intake through regression analysis (SAS, ver. 9.1) predicting feed intake by using body weight, ADG, changes in fat depositions, and changes in hip height (REG). Via a Calan gate feeding system, feed amounts were recorded daily and refusals measured weekly. The diets studied were Period 1 (P1) a low energy diet, ad libitum brome hay with a 20% CP pelleted supplement fed at $2.21 \text{ kg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$, and Period 2 (P2) a high energy, high concentrate diet with approximately 20% roughage ($NE_m = 1.91 \text{ Mcal/kg}$, $NE_g = 1.19 \text{ Mcal/kg}$). Heifers were fed individually for 162 d (70 d P1, 22 d adaptation, and 70 d P2). Shrunken BW were taken at the beginning, middle, and end of each period. Additionally, hip heights and ultrasound measurements for backfat

and marbling were measured. Spearman Rank correlations between P1 and P2 for RFI were positively correlated ($r = 0.42$, $P < 0.03$) but not for FGR and REG ($r = 0.18$, $P < 0.37$; $r = 0.05$, $P < 0.81$, respectively). Data indicate a positive correlation between ranking of RFI and FGR for P1 ($r = 0.96$, $P < 0.0001$), and P2 ($r = 0.83$, $P < 0.0001$). Ranking of RFI and REG was not similar ($r = 0.26$, $P = 0.19$) for P1 but was significant and positive for P2 ($r = 0.38$, $P = 0.06$). This study shows that low- and high-energy dense diets can be used to rank calves for feed efficiency with similar results when using RFI but not other measures of feed efficiency. Within a particular diet type it appears that feed efficiency can be calculated by several different equations and those methodology can be used to rank individuals in a similar order.

Key Words: Feed efficiency, Residual feed intake, Beef heifers

222 Effects of different selection criteria on profitability in beef bulls. J. Gulas*, J. Warren, and E. Felton, *West Virginia University, Morgantown.*

Analysis of data from two bull tests (yr1 & yr2; $n = 266$) was conducted examining the relationships between various production traits including residual feed intake (RFI). RFI was determined by regression analysis of DMI on midpoint MBS and ADG. Data were analyzed by the CORR and GLM procedures of SAS utilizing each year's data independently and combined. Utilizing RFI as a selection tool has been previously discussed as an independent measure of efficiency compared to G:F and Feed:Gain (F:G). In our analysis, RFI was independent of most production variables. There was a strong positive relationship ($P < 0.05$) between RFI and total test DMI, as well as F:G for yr1, yr2, and years combined. Frame score and RFI, had no relationship to one another in yr1, had a weak positive relationship ($P < 0.05$) in yr2, and a trend for a weak relationship with years combined. This may indicate that smaller frame bulls are more efficient. However, there was a negative relationship ($P < 0.05$) between G:F and test entry weight; lighter bulls were more efficient. Thus heavier bulls would be selected against if traditional measures of efficiency were used. Regardless of this information producers were reluctant to utilize efficiency data in determining the cost they were willing to pay. Sale price had the strongest relationships ($P < 0.05$) in yr1 with rib-eye area (REA), sale order, final BW, and % i.m. fat and adjusted yearling weight, weight per day of age (WDA), final BW and sale order in yr2 respectively. When years were combined, sale order, adjusted yearling weight, total test DMI, and WDA had the greatest impact on sale price ($P < 0.05$). Dam's age had a negative relationship with REA and sale price ($P < 0.05$) for yr1. In yr2, as the dam's age increased so did the birth weight, WDA, final BW and frame score. When years were combined, birth weight, WDA, frame score, and total test DMI increased as the dam's age increased ($P < 0.05$). This data indicates that RFI can be used as a selection tool without a fear of also selecting for undesirable traits and that sale order and performance rather than carcass attributes are major selection criteria for bulls purchased in these tests.

Key Words: Beef, RFI, Efficiency

223 Comparison of corn and grain sorghum dried distillers grains as protein supplements for growing beef heifers. K. W. Harborth*, D. A. Llewellyn, and T. T. Marston, *Kansas State University, Manhattan.*

An experiment was conducted to determine if corn and grain sorghum dried distillers grains could be effective protein supplements for growing beef heifer calves. Angus crossbred heifers ($n = 77$) were individually fed $2.72 \text{ kg} \cdot \text{head}^{-1} \cdot \text{day}^{-1}$ (DM basis) of a 20% CP supplement. Heifers had access to smooth brome hay (CP = 10.8%) fed in round bale feeders while grazing a common dormant native-grass pasture for 57 d. During the final segment of the experiment the heifers were removed from the pasture and fed free-choice smooth brome hay for an additional 14 d. The three supplements compared were: 1) SBM: 50% cracked corn, 25% soybean meal, and 25% ground grain sorghum; 2) CDDGS: 50% cracked corn and 50% corn distillers grains with solubles, and 3) GSDDGS: 50% crack corn, 31% sorghum distillers grains with solubles, and 19% ground grain sorghum. Supplements were isonitrogenous. Beginning, intermediate, and final shrunken body weights were used in the analysis. During the last week of the trial, four heifers from each supplemental treatment ($n = 12$) were used to determine diet digestibility. Digestibility was determined by using total diet intake, the amount of ADIA consumed, and the concentration of ADIA in the feces. Average daily gains were similar ($P < 0.13$) between SBM, CDDGS, and GSDDGS treatments (0.54, 0.61, and 0.55 kg/d, respectively). Treatment had no effect on total tract digestibility ($P < 0.84$) or dry matter intake ($P < 0.39$). These results indicate that producers can expect similar growth performance and diet digestibility regardless of the grain source of dried distillers grains used to formulate a 20% crude protein supplement fed at about 1% of body weight.

Table 1. Total tract digestibilities

	Supplement			
	SBM	CDDGS	GSDDGS	SEM
No. Heifers	4	4	4	
Avg Wt, kg	328.3	329.7	345.6	10.6
DDMI, kg	7.4	6.3	7.4	0.64
DDMI, %BW	2.24	1.90	2.14	0.133
DMD, %	65.8	68.6	70.6	5.75

Key Words: Distiller's grains, Beef heifers, Protein supplementation

224 Effect of time on dry matter yield and forage quality of swathed oat and unharvested corn forages. K. Schulz¹, W. Poland^{*2}, L. Tisor², and S. Turbiville¹, ¹Dickinson State University, Dickinson, ND, ²North Dakota State University, Dickinson.

Increasing the grazing season of beef cows into the fall and early winter has the potential to reduce the expenses associated with traditional forage feeding practices. The potential to extend the grazing season depends on retention of dry matter (DM) yield and forage quality. The objectives of this experiment were to compare changes in DM yield and forage quality of unharvested corn (*Zea mays*; CO) and swathed oat

(*Avena sativa*; SW) to oat harvested as hay (HY). Average DM yield ($P < 0.01$) and IVDMD ($P < 0.01$) was greatest in CO. Average DM yield ($P = 0.10$; 2764, 2139 and 1715, lb/ac for CO, HY and SW, respectively) and IVDMD concentration ($P < 0.01$; 66.0, 61.2 and 48.8%, respectively) was greater in HY compared to SW. Daily rate of DM disappearance ($P = 0.13$; -12.91, -.73 and -6.16 lb/ac) and the daily loss of IVDMD concentration (-.098, -.025 and -.062%) was greatest in CO, least in HY and intermediate in SW. Average CP concentration ($P < 0.01$) was greatest in HY, least in SW and intermediate in CO (14.6, 17.0 and 11.9%). Daily loss of CP concentration (-.013%, $P < 0.05$) was similar across treatments ($P = 0.42$). Average fiber concentrations ($P < 0.01$) were greatest in SW, least in HY and intermediate in CO. Daily increase in fiber concentrations were greatest in CO, least in HY and intermediate in SW. Ash concentration was not affected by forage type or sampling date. Daily changes in DM yield ($P > 0.80$) and concentrations of IVDMD ($P > 0.20$), ADF ($P > 0.70$) and NDF ($P > 0.50$) of HY did not differ from 0. With the exception of CP concentration, DM and forage quality of oat hay was relatively stable in the fall and early winter of the year of harvest. Unharvested corn had greater average and daily loss DM yield and digestibility compared to swathed oat. However despite changes in DM yield and forage quality in these forages, both unharvested corn and swathed oat appear to offer alternative forage options for beef cows in the fall and early winter.

Key Words: Forages, Unharvested corn, Swathed oat

225 Effect of alternative winter feeding methods on cow performance and production costs. S. Turbille¹, W. Poland*², K. Schulz¹, and L. Tisor², ¹Dickinson State University, Dickinson, ND, ²North Dakota State University, Dickinson.

Winter feeding is a major expense in cow-calf operations in the Northern Plains. The objectives of this study were to compare cow performance and associated costs of nontraditional feeding programs in southwestern ND. Young beef cows ($n = 49$; BW = 560.2 ± 59.9 kg; body condition score [BCS] = $5.9 \pm .6$) were randomly assigned to one of three treatments. Treatments included grazing of swathed oat (*Avena sativa*; SW), grazing of unharvested corn (*Zea mays*; CO) or oat hay feeding in dry lot (DL). Number of cows allocated to each replicate was based upon amount of forage available at the initiation of the study and an intended 8-wk feeding period beginning in mid October. Cumulative changes in BW and BCS averaged 49.9 kg and .02 units, respectively. Hay fed in DL was provided ad libitum ($19.0 \pm .23$ kg/d). Number of grazing days per cow ($P = 0.94$) was similar across treatments (51.3, 52.5 and 51.0 for SW, CO and DL, respectively). Number of grazing days per ha ($P = 0.40$) was numerically greater for CO (159.6), intermediate for DL (122.4) and least for SW (99.8). Cumulative ADG (kg/d, $P = 0.05$) was reduced in SW (.59) compared to CO (1.09) and DL (.95). Cumulative change in BCS ($P = 0.20$) was similar across treatments (-0.10, 0.25 and -0.19 for SW, CO and DL, respectively). Total production and use costs per acre were \$68.50, \$195.10 and \$95.93 for SW, CW and DL respectively. Costs per cow grazing day ($P = 0.29$) and per lb of BW gain ($P = 0.70$) did not differ among treatments. Numerically, however, costs per day were least in SW (\$0.67), greatest in CO (\$1.31) and intermediate in DL (\$0.89). Likewise, numerically cost per unit of gain was least in DL (\$0.42) compared to SW (\$0.54) and CO (\$0.54). Results suggest that each feeding alternative is feasible in southwestern

ND. However, other elements of nontraditional systems (e.g. manure disposal, machinery and labor requirements) will need to be valued if they are to be adopted as "better" alternatives.

Key Words: Beef cows, Unharvested corn, Swathed oat

226 Effect of calving date on stocker and feedlot performance of calves born in the Northern Great Plains and finished in the Southern Great Plains. W. A. Phillips*¹, E. E. Grings², R. E. Short², R. K. Heitschmidt², and H. S. Mayeux¹, ¹USDA-ARS Grazinglands Research Laboratory, El Reno, OK, ²USDA-ARS Livestock and Range Research Laboratory, Miles City, MT.

Changing the calving season from late winter to late spring can have large effects on outputs from rangeland-based beef operations in the Northern Great Plains. The objective of this study was to determine the effect of calving season on subsequent stocker and feedlot performance. Calves ($n = 169$) were born in late winter (LW; February), early spring (ES; April) or late spring (LS; June) in rangeland-based beef operations in the Northern Great Plains. Each year ($n = 3$), calves were weaned in October and shipped 1900 km to El Reno, OK. After a 14-d recovery period, calves grazed annual cool season grasses for 196 d (Stocker phase) before being fed a high energy diet for 133 d (Finishing phase). Data were analyzed using a mixed model with calving season as the independent variable. Calf was the experimental unit and year was considered to be random. Delaying calving resulted in lower ($P < 0.01$) initial stocker calf BW (LW = 281 kg; ES = 248 kg; LS = 193 kg; SE = 5), but increased ($P > 0.01$) the amount of BW gained during the stocker period (LW = 141 kg; ES = 145 kg; LS = 150 kg; SE = 2). During the finishing period, initial BW (LW = 429 kg; ES = 388 kg; LS = 339 kg; SE = 6) and hot carcass weight (LW = 346 kg; ES = 332 kg; LS = 317 kg; SE = 5) were greater ($P > 0.01$) for calves born earlier in the year as compared to calves born later in the year, but ADG (LW = 1.13 kg; ES = 1.20 kg; LS = 1.25 kg; SE = .02) was lower ($P < .01$). Dressing percentage ($61.3 \pm 0.3\%$) and longissimus muscle (81.9 ± 1.2 cm³) were similar among the three CS groups. Delaying the calving season produced lighter stocker calves that gained weight more rapidly than heavier stocker calves during the stocker phase. However, during the finishing phase lighter younger calves had to be fed longer than heavier older calves and produced lighter carcasses at the end of the finishing phase.

Key Words: Stocker calves, Calving season, Growth

227 Effect of value-added health program and breed on calf prices: Superior Livestock Auction analysis. L. Corah¹, M. McCully*¹, M. King², M. Salman², J. Seeger³, and D. Grotelueschen³, ¹Certified Angus Beef LLC, Wooster, OH, ²Colorado State University, Fort Collins, CO, ³Pfizer Animal Health, New York, NY.

To determine effect of vaccination program on calf prices, records were collected on 3,121,970 beef calves sold in 25,847 lots through Superior Livestock Auction via video (1995-2005). Data on breed effect were recorded for five years (2001-2005) on 1,725,811 calves from 14,382 lots. A multiple regression model quantifying the effects of independent factors on the sale price of beef calves was developed using a backwards selection procedure in each year of the study. Value-added health programs were 1) may have received clostridial, pasteurella vaccines, but

not respiratory viral vaccines (NT); 2) clostridial, pasteurilla, and 4-way respiratory vaccine at 2-4 weeks pre-shipment (Vac 34); and 3) full vaccination schedule plus boosters at weaning and weaned 45 days pre-sale (Vac 45). Breeds were classified as 1) mixed English, English crosses; 2) English-Continental crosses; 3) primarily Angus; 4) black or black white faced; and 5) cattle with ear. The lots of cattle reported as non-viral vaccinated declined from 45% in 1995 to 4% in 2005, while the percentage pre-weaned and vaccinated (Vac 45) increased from 3% in 1995 to 27% in 2004. Using NT as base, the premium/cwt for Vac 34 ranged from \$0.99 in 1996 to \$3.47 in 2004 and for Vac 45 from \$2.47 in 1995 to \$7.91 in 2004; values between vaccine treatments within year differ ($P < .05$). Using cattle with ear as base, the premiums/cwt for English-English cross calves ranged from \$1.74 in 2001 to \$4.33 in 2004, for English-Continental crosses \$2.22 in 2002 to \$3.94 in 2004, for primarily Angus calves from \$4.60 in 2001 to \$6.77 in 2004, and for black or black white faced calves \$3.79 in 2002 to \$5.57 in 2004; pooled premium/cwt values for breed classification were 0, 2.90, 2.93, 5.58, and 4.42, respectively. Values between breed classification within year differ ($P < .05$). Both type of vaccination program and breed had a significant effect on calf sale prices.

Key Words: Vaccination program, Calf price, Breed

228 Dry matter intake prediction of steers and heifers in the feedlot: Effect of initial weight on dry matter intake. H. Koknaroglu¹, D. D. Loy², and M. P. Hoffman^{*2}, ¹*Suleyman Demirel University, Isparta, Turkey*, ²*Iowa State University, Ames*.

Close-out information, generated by Iowa State University Feedlot Performance and Cost Monitoring program submitted from January 1988 through December 1997 by Iowa cattle producers to Iowa State University, was examined to determine effect of initial weight on DMI of steers and heifers in the feedlot. Close-out information consisting of 2463 pens of steers and 985 pens of heifers included information on start and end date, cattle per pen, sex, housing type, days on feed, initial and sale weight, feed conversion (FC), proportion of concentrate, ADG, percent death loss, feed cost and total cost per 45.35 kg gain, breakeven sale price, non-feed variable cost, non-feed fixed cost and corn price. Daily DMI was not provided but was calculated as $DMI = ADG \times FE$. Regression model included initial weight and thus DMI was regressed on initial weight for steers, heifers and combination of both. When the model was applied separately for steers, heifers and including both sexes, DMI prediction for steers was found as $DMI = 5.81 + 0.0125 \times \text{Initial weight}$ ($n=2445$, $r^2=0.41$), whereas DMI prediction for heifers was found as $DMI = 5.03 + 0.0144 \times \text{Initial weight}$ ($n=965$, $r^2=0.38$). When steers and heifers were combined, DMI prediction was found as $DMI = 5.49 + 0.0133 \times \text{Initial weight}$ ($n=3410$, $r^2=0.43$). These results are similar to those obtained by NRC (1996) where it was found $DMI = 4.54 + 0.0125 \times \text{Initial weight}$. These prediction models predict average feed intake throughout a feeding period and implies that initial weight of cattle is related to average DMI during a feeding period. Slope for heifers was higher than that of steers, implying that heifers had a greater increase in DMI throughout a feeding period per unit of initial body weight.

Key Words: Dry matter intake, Prediction, Initial weight

229 Survey of cattle backgrounding and finishing feedlots in North Dakota. T. G. Rime, K. R. Maddock Carlin*, W. D. Eide, G. P. Lardy, and K. G. Odde, *North Dakota State University, Fargo*.

To evaluate North Dakota's current supply of fed cattle and potential to supply additional fed cattle, a survey was administered to 148 beef cattle backgrounders and finishers in North Dakota with an estimated one time capacity > 500 hd. The survey was conducted via face to face interviews in spring of 2005. Operators were asked questions pertaining to current and potential capacities, characteristics of cattle being fed, general management practices, feeding practices, marketing strategies, and interest in producing "natural beef". A total of 130 respondents completed the survey. North Dakota had 99,385 cattle on feed in spring of 2005 with 240,420 hd fed annually. Total feedlot capacity was 188,693 hd with an average capacity of 1,452 hd and an average inventory of 771 hd. The majority of the cattle were backgrounded (65%), while only 37 percent of the cattle were finished. The majority of cattle being fed in ND were Angus-based (59%). Continental-based breeds accounted for 23 percent of cattle and other British breeds accounted for 17 percent. Forty-seven percent of operators did not use growth implants. Cattle in ND were marketed primarily through local auctions (26%) and contracts with slaughter plants (32%). Sixty seven percent of slaughter cattle were sold on a live basis and 24 percent were marketed on a grid. Feed inputs were mainly produced on the farm or ranch (78%), whereas only 2 percent of feed was purchased and processed commercially. Corn was the main concentrate feed (47%) and silage was the main forage (40%). Operators reported 54 percent of cattle were custom fed, of which 92 percent were fed using yardage and feed arrangements. The majority of operators (59%) indicated an interest in expanding their feedlots. Implementation of a "natural beef" program was of interest to 58 percent of operators. However, respondents indicated a 14 percent increase in price would be required to raise "natural beef". The results of this survey indicate an interest in increasing feeding capacity in North Dakota. Feeders expressed interest in feeding for a "natural beef" program, provided higher prices were paid for these cattle.

Key Words: Backgrounding, Feeding, North Dakota

230 Survey of small meat processors in North Dakota. T. G. Rime, K. R. Maddock Carlin*, W. D. Eide, T. D. Maddock, P. T. Berg, M. J. Marchello, G. P. Lardy, and K. G. Odde, *North Dakota State University, Fargo*.

In order to determine offal production and the potential for a new rendering facility in North Dakota, a survey of small meat processors was conducted. The survey addressed four topics: 1) amounts and types of offal produced; 2) geographic distribution of offal; 3) seasonal trends of production; and 4) current methods of offal disposal. A total of 117 plants were contacted and personally visited. Data collected from the processors were grouped into four quadrants based on geographical location. In the southeast, southwest, northeast, and northwest, there were 37, 33, 25, and 22 plants, respectively. The total offal production in North Dakota was 7,430,266 kg annually. Processing plants in North Dakota produced 5,233,818 kg of beef offal from 21,603 head; 608,716 kg of hog offal from 11,645 head; 12,588 kg lamb offal from 454 head; 545,580 kg of bison offal from 2,598 head; 623,159 kg of deer and elk

offal from 26,231 head; and 406,405 kg of boxed beef offal. The south-east region of North Dakota produced the greatest amount of offal (2,272,277 kg), followed by the southwest (1,937,285 kg), northwest (1,821,714 kg), and northeast (1,398,989 kg). Seasonal production of renderable offal varied slightly as 23.4 percent of total offal is produced in both quarters 2 and 3 and 28.1 percent is produced in quarter 4 indicating a fairly stable supply of offal throughout the year. Offal in North Dakota was disposed of in three ways: 1) rendered; 2) deposited in a municipal landfill; 3) deposited in a private landfill. As there are no available rendering facilities in North Dakota for small processors, the

majority of renderable offal is collected and processed in Minnesota. Approximately 55.8% of all offal is rendered. Municipal landfills received 25.2 % of all offal, of which 85.2% is from the western quadrants. Private landfills received 19.0% of total offal, of which 83.5% is from the western quadrants. In conclusion, data from this survey compile information on offal production in North Dakota. There appears to be insufficient offal production in North Dakota to support a new rendering facility.

Key Words: Offal, Survey, Beef

Breeding and Genetics

231 The effect of single nucleotide polymorphisms on one-step Tukey's biweight estimates from affymetrix microarray data.

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It has recently been proposed that the use of Affymetrix microarrays on individuals from outbred populations may result in biased measures of gene expression for probes for which the population harbours a single nucleotide polymorphisms (SNPs). However, Affymetrix Microarray Analysis Suite 5.0 (MAS5) employs a robust estimator, the one-step Tukey's biweight (TBW), to calculate expression measures. The objective of this study was to evaluate the robustness of TBW to the presence of SNPs. A publicly available dataset from the Affymetrix HG-U133A 2.0 array was used. Fifty probe sets, each with 11 probe pairs, were randomly selected from the array. After background correction following the MAS5 algorithm, various numbers of adjacent Perfect Match (PM) signals were replaced by corresponding Mismatch (MM) signals, thus using MM signals to mimic a SNP affecting multiple probe pairs with overlapping sequences. TBW estimates calculated from the logs of the 'new' set of 'PM' signals, without any other PM corrections, were fitted with a mixed linear model, with the number of replaced PMs as fixed effect and probe set and its interaction with number of replaced PMs as random effects. Dunnett's procedure was used to evaluate the effect of number of PMs replaced. The percent decrease in expression measures were also regressed on the number of PMs replaced. Results showed that TBW is robust to replacement of 1 PM signal with a corresponding MM signal, showing no significant decrease in the expression measure (adjusted p-value>0.05). If four or more adjacent PMs were replaced, TBW estimates did decrease significantly (adjusted p-value<0.01). The percent decrease in the expression measure was approximately linear with the number of PMs replaced. With one more PM signal replaced, the TBW estimate decreased by approximately 5% of the original value on average. In conclusion, TBW estimates are robust to presence of SNPs. One should, however, be cautious when a gene with four or more overlapping probe pairs is detected to be 'differentially expressed' in a comparison where the presence of a SNP could be confounded with 'treatment'.

Key Words: SNP, Tukey's biweight, Microarray

233 QTL mapping in an F₂ Duroc × Pietrain resource population: I. Growth traits.

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Pigs from the F₂ generation of a Duroc x Pietrain resource population were evaluated to discover quantitative trait loci (QTL) affecting growth and composition traits. Body weight and ultrasound estimates of tenth rib backfat, last rib backfat, and *longissimus* muscle area were serially measured throughout development. Estimates of fat-free total lean, total body fat, empty body protein, empty body lipid, and average daily gain from 10 to 22 wk of age were calculated, and random regression analyses were performed to evaluate phenotypes representing intercept and linear rates of increase in these eight serial traits. A total of 510 F₂ animals were genotyped for 124 microsatellite markers evenly spaced across the entire genome. Data were analyzed with line cross least squares regression interval mapping methods using sex and litter as fixed effects. Significance thresholds of the F-statistic for additive, dominance, and imprinted QTL were determined on chromosome- and genome-wise levels by permutation tests. A total of 54 QTL for 21 of the 28 measured traits were found to be significant at the 5% chromosome-wise level. Of these 54 QTL, 5 were significant at the 1% chromosome-wise, 1 at the 5% genome-wise, and 10 at the 1% genome-wise significance thresholds. A total of 33 QTL for 15 of the 16 animal random regression terms were found to be significant at the 5% chromosome-wise level. Of these 33 QTL, 9 were significant at the 1% chromosome-wise, 0 at the 5% genome-wise, and 2 at the 1% genome-wise significance thresholds. Putative QTL were discovered for tenth rib and last rib backfat on SSC 6, body composition traits on SSC 9, backfat and lipid composition traits on SSC 11, tenth rib backfat and total body fat tissue on SSC 12, and linear regression of body weight, *longissimus* muscle area, and tenth rib backfat on SSC 18. These results will facilitate fine mapping efforts to identify genes controlling growth and body composition of pigs that can be incorporated into marker-assisted selection programs to accelerate genetic improvement in pig populations.

Key Words: Growth, Pigs, Quantitative trait loci

234 Mapping of the *FMO3* gene may explain a QTL for off

flavor in pork on SSC9. K. L. Glenn*¹, E. McCormick², A. M. Ramos¹, and M. F. Rothschild¹, ¹*Iowa State University, Ames*, ²*Mount Mercy College, Cedar Rapids, IA.*

Off flavors in pork sometimes produce tastes such as sourness, fishy, metallic or other non-typical flavors including boar taint. Some of these

off flavors may be attributed to environmental causes but others could be genetic in nature. A loss of function mutation in flavin-containing mono-oxygenase 3, *FMO3*, is known to be associated with a fishy off flavor in both chicken eggs and cow's milk and a similar autosomal recessive disorder is present in humans resulting in a fishy odor. These result from an over abundance of the odorous trimethylamine (TMA). A quantitative trait locus (QTL) for off flavor has been identified on porcine chromosome 9 using the Iowa State University Berkshire x Yorkshire (BxY) reference family (Malek et al. 2001). Comparative mapping suggested that *FMO3* might map to this region. Primers were designed in areas of homology between the human *FMO3* gene and porcine ESTs. An intron 8 single nucleotide polymorphism (SNP) was chosen from several SNPs found and was used to linkage map *FMO3* to pig chromosome 9 (SSC9) by genotyping the BxY population. A QTL analysis was performed using the map containing *FMO3* with results showing that *FMO3* is located 2 cM away from the peak of the off flavor QTL previously detected on SSC9. Several BxY animals were then chosen for amplification based on their off flavor taste test score ranging from 0 (no off flavor) to 9 (considerable off flavor). These animals were then sequenced in order to look for differences at the DNA level between animals with high and low off flavor scores. Further analysis of new SNPs within this gene will be presented.

Key Words: Swine, PCR-RFLP, Mapping

235 Association between growth hormone gene (GH) SNP and economic traits in pig. D. Paiva, S. Paiva, P. Lopes, and S. Guimaraes*, *Departamento de Zootecnia, Universidade Federal de Vicosa, Vicosa, Minas Gerais, Brasil, 36571-000.*

The native Brazilian breeds of pig have not yet been fully evaluated using genetic methods, and since they are no longer of economic importance, they are now in extinction process, being replaced by imported commercial breeds. In the present study, a F2 population generated by the crossing of two native Brazilian sires and 18 commercial dams were genotyped to G316A variation in growth hormone gene (GH). A total of 402 animals were genotyped and three genotypes (GG, GA and AA) were found. Their frequency were 0.57, 0.4 and 0.03, respectively. Association analyses between the G316A genotype and phenotypic traits were performed using a statistical model that included genotype, sex and group as fixed effects and sire as random effect. It was investigated the existence of interaction between sex and genotypes. The SNP was associated with number of right nipples ($p = 0.03$), heart weight ($p = 0.04$), lung weight ($p = 0.05$), picnic shoulder weight ($p = 0.07$), pH 24 hours after slaughter ($p = 0.03$) and drip loss ($p = 0.01$). The effect of allelic substitution was significant ($p < 0.10$) for heart weight and pH 24 hours after slaughter. The effect of dominance was significant ($p < 0.05$) for number of right nipples, heart weight, picnic shoulder weight and pH 24 hours after slaughter. It was observed the association between polymorphisms and sex for six performance traits. The GA genotype was found in both parental breeds, but the GG genotype was found only in commercial sows, and in the F2 animals it showed the best averages for the main productive traits. This work showed that the GH gene is a potential candidate gene for quantitative traits and suggested its application in breeding programs, however the effects linked to this SNP have to be validated in commercial herds.

Key Words: Candidate gene, Production traits, Meat quality

236 Additive and dominance genetic effects on sow longevity.

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The purpose of current study was to estimate variance components, especially dominance genetic variation and genetic correlation between purebred and crossbred populations, for overall leg action, length of productive life, and sow stayability until third and fifth parity. The study was carried out by analyzing the data from Finnish litter recording scheme. There were information on 23,602, 22,984, and 17,440 sows in the Landrace (LR), Large White (LW), and crossbred (LR x LW) datasets, respectively. In the statistical analysis, same phenotypic traits evaluated on different breeds were treated as correlated characters. Five different statistical models were fitted on the data. First, the simplest model (A) contained the fixed effect of herd-year, and the random additive genetic effect in the statistical model for all the traits. In addition to these effects, the fixed effect of scorer and fixed linear regression of test weight were included in the statistical model for overall leg action. Next, sows' inbreeding (AF), common litter environment (AL), inbreeding and common litter environment (ALF), and inbreeding and common litter environment and parental dominance (ALFD) effects were added to the statistical model. The estimated heritabilities ranged between 0.03 and 0.12, and proportions of dominance variance to total phenotypic variance (d^2) ranged between 0.03 and 0.12. Heritability estimates were similar between the breeds, whereas d^2 estimates were clearly higher in crossbred population than in purebred populations. The genetic correlations of the same phenotypic trait between purebred and crossbred populations were over 0.75. However, the correlation estimates obtained from the simplest model (A) were slightly lower than those from more complicated models (ALF, ALDF). Based on current results, accounting for dominance genetic effects in breeding value estimation may result in only slight increase on genetic gain of crossbred sows. However, more research is needed to evaluate the potential of utilizing dominance genetic effects more efficiently when planning specific matings.

Key Words: Sow longevity, Crossbred, Dominance

237 Estimation of genetic trend in IGF-I concentration and correlated response in growth traits in lines of Angus beef cattle divergently selected for serum IGF-I concentration. W. C. Huang*, H. C. Hines, and M. E. Davis, *The Ohio State University, Columbus.*

A divergent selection experiment was established in 1989 to investigate developmental patterns of serum IGF-I concentrations and body growth in purebred Angus cattle. One-hundred spring-calving (50 high line and 50 low line) and 100 fall-calving (50 high line and 50 low line) cows with unknown IGF-I concentration were randomly assigned to the selection lines at the Eastern Agricultural Research Station, Belle Valley, OH. Results of this study included the 1989 through 2002 calf crops. The objectives of this study were to estimate genetic parameters for growth traits and IGF-I concentrations and to estimate direct and correlated responses to divergent selection for IGF-I concentrations. (Co)variance components were estimated for direct and maternal additive effects using an animal model and MTDFREML computer programs. Estimated breeding values were also calculated. Estimates of direct heritability for growth traits from a single trait model were generally moderate and ranged from 0.33 to 0.62 with birth weight having the smallest

heritability and gain during the 20-d adjustment period after weaning having the highest heritability. Heritability estimates for direct effects were 0.38 ± 0.07 , 0.42 ± 0.07 , 0.33 ± 0.07 , and 0.44 ± 0.07 for IGF-I concentration at d 28, 42, and 56 of the postweaning period, and for mean IGF-I concentration, respectively. Maternal heritability and the proportion of phenotypic variance due to permanent environmental effect of dam were generally < 0.23 for growth traits and IGF-I concentrations. Cattle in the high line had significantly ($P < 0.05$) higher direct effect of mean IGF-I concentration than those in low line (High: 48.5 ng/mL vs Low: -22.2 ng/mL) at the end of the study. For correlated responses of all growth traits, the differences were not significant. The low line had larger values than the high line for direct genetic effects for weight and gains. Results demonstrated that selection for serum IGF-I concentration would be effective and that serum IGF-I concentration may be a useful selection criterion.

Key Words: Beef cattle, Genetic parameters and trends, IGF-I

238 Breeding for sustainability: effect of breed on cultural energy expenditure of lamb production. H. Koknaroglu¹, A. Ali², D. G. Morrical², and M. P. Hoffman*², ¹*Suleyman Demirel University, Isparta, Turkey*, ²*Iowa State University, Ames*.

Data from a study conducted to evaluate post-weaning growth and carcass traits of Texel, Suffolk and Columbia sired offspring were used

to evaluate effects of breed on cultural energy expenditure of lamb production. Each year whiteface ewes ($n=82$), composed of primarily Polypay x Dorset ewes, were exposed to Texel, Suffolk or Columbia rams for a 35 day breeding season. The ewes were wintered outdoors on average quality alfalfa hay according to NRC (1985) requirements and were not provided any concentrate during late gestation or lactation. Ewes were turned out onto 6.07 ha of pre-dominantly cool season grass pasture divided into five 1.21 ha paddocks with electrified fence in early May. Ewes were rapidly rotated through paddocks initially to stagger grass growth. A total of 279 lambs were born with an average of 1.7 lambs per ewe and weaned lambs were used in the study. The lambs were weaned at 70 days of age and lambs from each sire breed were placed either in feedlot or on pasture. Lambs in the feedlot were fed shelled corn and pelleted protein supplement. Lambs on pasture grazed for 63 days and received 455 g concentrate daily and later placed in feedlot. For cultural energy analysis, pasture establishment and maintenance, feed in feedlot and on pasture, transportation, labor, machinery, electricity and other inputs were calculated and corresponding values for each input were obtained from literature. For analysis it was assumed that 20 percent of ewes were culled and lambs sold after weaning were included in the analysis. Texel sired lambs tended to have lower energy input per kg live weight than Columbia sired lambs ($P > 0.09$). There was no difference among breeds in terms of energy input per kg carcass ($P > 0.4$). Suffolk sired lambs had lower cultural energy ratio for protein energy output than Columbia sired lambs ($P < 0.005$). Energy output ratio, defined as kcal input/kcal output, was better for Suffolk sired lambs and it was different from that of Columbia sired lambs ($P < 0.01$).

Key Words: Cultural energy, Sustainability, Breed

Growth and Development, Muscle Biology, and Meat Science

239 Instrument prediction of pork carcass composition. D. Newman*¹, T. B. Schmidt¹, E. L. Walker², C. A. Stahl¹, G. K. Rentfrow¹, D. L. Meyer¹, V. L. Pierce¹, M. R. Ellerseick¹, and E. P. Berg¹, ¹*University of Missouri, Columbia*, ²*Missouri State University, Springfield*.

The objective was to provide the United States Department of Agriculture (USDA) Agricultural Marketing Service a means of standardizing pork carcass composition assessment equipment. Grading equipment included a stainless steel ruler, Fat-O-Meater (FOM), Automatic FOM (AFOM), Carcass Value Technology System 1 (CVT1; 17 cm, 5049 transducer), CVT System 2 (CVT2; 12.5 cm 5011 transducer), Hennessy Grading Probe (HGP), and the Ultrasound FOM (UFOM). Barrow and gilt carcasses ($n=312$) selected over eight weeks to meet the average backfat thickness and carcass weight for selection cells based on three endpoints of hot carcass weight and three last rib fat depth endpoints (median, high, and low). Carcasses were dissected into four lean cuts (ham, loin, picnic shoulder, and Boston butt) and weighed at 6.3, 3.2, and zero mm external fat depth. Soft tissue from the four lean cuts was collected, mixed, ground, re-mixed and subsampled for analysis of total ether extractable lipid. Fat-free mass was calculated to two endpoints: fat-free lean = dissected soft tissue (ST) wt - [ST lipid weight/%lipid of pure fat sample] and lipid-free lean = ST wt - (ST wt*%lipid of ST). Linear regression analysis was performed using the representative fat and lean tissue depths (or loin muscle area as output by the AFOM) obtained from each electronic grading instrument to predict each yield

endpoint. Correlation coefficients were evaluated across instrument output and with carcass yield. Final prediction equations were determined using the STEPWISE procedure of SAS retaining independent variables at a level of $P < 0.10$. The highest correlations were seen between the FOM and HGP ($r = 0.94$), CVT1 and CVT2 ($r = 0.93$), and last rib fat thickness and AFOM last rib fat thickness ($r = 0.915$) all at $P < 0.01$. Precision and accuracy of each instrument are similar, except ultrasonic FOM consistently presented the lowest R² and highest RMSE statistics. When the new equations (developed from these data) were applied to predict compositional yield, no differences were observed across all instruments for yield prediction, suggesting that these equations can be used as an industry standard.

Key Words: Carcass yield, Grading equipment, Pork

240 Impact of phosphate type and cooking method on the water holding capacity and texture of reheated pre-cooked turkey breast rolls. G. Dunlap*, H. Zerby, and M. Wick, *The Ohio State University, Columbus*.

The objective of this study was to determine the effect of phosphate type on initial production and subsequent reheating of turkey rolls.

Breast muscles (51 kg) were selected on three different production dates from a turkey processor and transported to The Ohio State University Meat Lab at $< 4^{\circ}\text{C}$. Breast muscles were ground through a 19 mm plate and mixed to produce a uniform meat block. The meat block was divided into three 17 kg portions and tumbled in three brine solutions: 1.5% salt, 1% dextrose, and 0.5% phosphate at 20% added solution. Phosphate treatments were: tetrasodium pyrophosphate (PY), sodium tripolyphosphate (STP) and disodium phosphate (DI). Batches were divided into 3.63 kg portions, stuffed into 15 cm diameter fibrous casings, and cooked to an internal temperature of 71°C . After chilling to $< 4^{\circ}\text{C}$, rolls were sliced at 10 mm, vacuum packaged and stored for 7 d at $< 4^{\circ}\text{C}$. Slices were divided into three reheating treatments: control (CNT; not reheated), microwave (MW), and convection oven (CV). Slices were reheated to 60°C for testing. Initial cook yields were greater ($P < 0.0005$) for DI (87.38%) and PY (87.28%) than STP (86.83%). Subsequent reheating of slices resulted in similar ($P < 0.005$) cook yields between DI (91.39%) and STP (90.38%), both of which were greater ($P < 0.001$) than that of PY (88.70%). Instrumental analysis resulted in no interactions between phosphate type and reheating method. The force required to break the protein gel matrix was different ($P < 0.02$) for all phosphate treatments with $\text{PY} > \text{DI} > \text{STP}$ (841.7 g, 745.3 g, 693.9 g, respectively). Slices reheated by MW (625.3 g) required less force to break the gel matrix than those of CV (717.3 g) and CNT (938.3 g). As a result of reheating, both the MW and CV slices required less force ($P < 0.0001$) to break the gel matrix than the CNT slices (938.4 g). Disodium phosphate had the greatest water holding capacity through both cooking steps. Reheating method and phosphate type can independently impact quality characteristics of precooked turkey breast rolls sold to consumers for reheating in the home.

Key Words: Turkey, Phosphates, Cooking

241 Effect of dietary fat source on the monounsaturated fatty acid (MUFA) composition of backfat from growing-finishing swine.

J. K. Apple*, C. V. Maxwell, D. L. Galloway, S. Hutchison, and J. T. Sawyer, *University of Arkansas, Fayetteville*.

Crossbred pigs were used to test the effect of dietary fat source (FAT) on the MUFA composition of backfat (BF) from growing-finishing swine. Pigs were blocked by BW, and, within blocks, pens (8 pigs/pen) were randomly assigned to corn-SBM diets with no fat (C) or diets containing 5% beef tallow (BT), poultry fat (PF), or soybean oil (SBO). One pig from each pen (8 pens/treatment) was randomly selected for slaughter initially (22.7 kg) and at mean pen weights (SWT) of 45.5, 68.1, 90.9, and 113.6 kg. Within 2 h of slaughter, a 4×6 -cm sample of clearplate was removed from left sides immediately posterior to the scapula, and subsequently separated into inner, middle, and outer layers for fatty acid analysis. There were $\text{FAT} \times \text{SWT}$ interactions ($P < 0.001$) for palmitelaidic (16:1t), palmitoleic (16:1c), oleic (18:1c9), and vaccenic (18:1c11) acids, as well as total MUFA. Percentages of 16:1t remained elevated from 45.5 to 113.6 kg in BT-fed pigs, but 16:1t decreased with increasing BW in pigs fed C, PF, and SBO. Although 16:1c decreased as BW increased, pigs fed PF had more 16:1c than other dietary treatments when slaughtered between 45.5 to 113.6 kg. Interestingly, 16:1c percentages were similar between pigs fed C and BT from 45.5 and 90.9 kg, but BT-fed pigs had more 16:1c than pigs fed C and SBO, which did not differ. Proportions of 18:1c9 increased substantially with increasing BW in pigs fed C, BT, and PF, with 18:1c9 percentages greater in BT-fed

than C- and PF-fed pigs; yet, 18:1c9 percentages did not change from 22.7 to 113.6 kg in SBO-fed pigs. Percentages of 18:1c11 decreased with increasing BW in BT- and SBO-fed pigs, but did not change from 22.7 to 90.9 kg in C-fed pigs; however, PF-fed pigs had greater percentages of 18:1c11 than all other treatments when slaughtered between 68.1 and 113.6 kg. Results indicate that including 5% SBO in diets of growing-finishing pigs dramatically reduces the proportion of MUFA in BF, whereas feeding 5% animal fat (BT or PF) produced similar elevations in MUFA.

Key Words: Dietary fat source, Monounsaturated fatty acids, Pork backfat

242 Effect of dietary fat source on the saturated fatty acid (SFA) composition of backfat from growing-finishing swine.

J. K. Apple*, C. V. Maxwell, D. L. Galloway, S. Hutchison, and J. T. Sawyer, *University of Arkansas, Fayetteville*.

Crossbred pigs were used to test the effect of dietary fat source (FAT) on the SFA composition of backfat (BF) from growing-finishing swine. Pigs were blocked by BW, and, within blocks, pens (8 pigs/pen) were randomly assigned to corn-SBM diets with no fat (C) or diets containing 5% beef tallow (BT), poultry fat (PF), or soybean oil (SBO). One pig from each pen (8 pens/treatment) was randomly selected for slaughter initially (22.7 kg) and at mean pen weights (SWT) of 45.5, 68.1, 90.9, and 113.6 kg. Within 2 h of slaughter, a 4×6 -cm sample of clearplate was removed from left sides immediately posterior to the scapula, and subsequently separated into inner, middle, and outer layers for fatty acid analysis. Proportions of palmitic (16:0) and all SFA were greatest ($P < 0.05$) in the inner BF layer and least ($P < 0.05$) in the outer layer. Stearic (18:0) acid increased in all BF layers as pig BW increased; however, 18:0 was greater in the inner than outer layer of pigs slaughtered at 45.5, 68.1, 90.9, and 113.6 kg (SWT \times layer, $P < 0.001$). There were $\text{FAT} \times \text{SWT}$ interactions ($P < 0.001$) for capric (10:0), lauric (12:0), myristic (14:0), 16:0, 18:0, and total SFA. Although 10:0, 12:0, and 14:0 percentages declined as BW increased, pigs fed PF and SBO had lower percentages of these fatty acids at 113.6 kg than pigs fed C and BT. The proportion of 16:0 increased with increasing BW; yet, C-fed pigs had greater, and SBO-fed pigs had lower, percentages of 16:0 between 45.5 and 113.6 kg than pigs fed BT or PF. Pigs fed C or BT had greater proportions of 18:0 than those fed PF and SBO between 45.5 and 90.9 kg; however, at 113.6 kg, pigs fed C had higher percentages of 18:0 than pigs fed 5% fat, whereas BF from pigs fed BT and PF had more 18:0 than SBO-fed pigs. The proportion of total SFA in the middle and outer BF layers of SBO-pigs did not change from 22.7 to 113.6 kg, and SFA percentages were the least in SBO-fed pigs, and greatest in C-fed pigs, regardless of BF layer or slaughter weight.

Key Words: Dietary fat source, Pork backfat, Saturated fatty acids

243 Effects of vitamin A supplementation in young lambs on performance, serum lipid, and carcass adipose tissue attributes.

A. Arnett*, M. Dikeman, C. Spaeth, B. Johnson, and B. Hildabrand, *Kansas State University, Manhattan*.

Forty crossbred wethers (BW = 28.7 kg) were used to evaluate the effects of diets containing high and low levels of vitamin A on carcass adipose tissue attributes. Four treatments were investigated:

backgrounding (BG) and finishing (F) with no supplemental vitamin A (LL); B with no supplemental vitamin A and F with high vitamin A (1,365 IU / kg diet) supplementation (LH); B with high vitamin A supplementation and F with no vitamin A supplementation (HL); B and F with high vitamin A (HH). Diets included cracked corn (62.4%), soybean meal (16.0%), cottonseed hull pellets (14.8%), and supplement (7%). The basal diet contained 360 to 380 IU vitamin A / kg from carotenes. During the BG period (d 1 to 56), feed intake was restricted to achieve 0.22 kg / hd / d gain. Lambs were fed the same basal diets *ad libitum* during the F period (d 57 to 112). Lambs were weighed every 14 d and bled every 28 d for serum fatty acid (FA) determination. Lambs were slaughtered after 112d. Twelfth rib fat thickness and longissimus lipid composition were measured. There were no differences ($P > 0.05$) in BW, ADG, or feed intake for the BG, F, or combined feeding phases. Hot carcass weight and backfat thickness were not affected by vitamin A level ($P > .20$). Carcasses from the HH group had higher ($P < .05$) marbling scores (514 vs. 459), and 25.8 % more extractable intramuscular lipid than LL (3.88 vs. 3.08 % for HH and LL, respectively, $P < .05$); the LH and HL treatments were intermediate. Degree of saturation of fatty acids was not affected by treatment ($P = .18$). Surprisingly, the LL group had the greatest increase in total serum FA throughout the experimental period (change of 126.8 vs. 41.4 Mg/g for LL and HH, respectively; $P < .01$). These data suggest that increases in total intramuscular lipid may be achieved with high levels of vitamin A supplementation for 112 d in young lambs without increases in subcutaneous fat.

Key Words: Vitamin A, Intramuscular fat, Lambs

244 Effects of triticale-based diets on finishing pig performance and pork quality in bedded hoop barns. Z. M. Sullivan*, M. S. Honeyman, L. R. Gibson, and K. J. Prusa, *Iowa State University, Ames.*

Triticale is a small grain resulting from an intergeneric cross between durum wheat and rye. The study consisted of four trials: two in winter (November 2003 through March 2004) and two in summer (May 2004 through September 2004) at the ISU Western Research and Demonstration Farm, Castana, Iowa. Each trial consisted of six pens of ten pigs (five barrows, five gilts) in three small-scale hoop barns (6.0 x 10.8 m). Pens were randomly assigned one dietary treatment: 1) corn-soybean meal control (0% triticale), 2) 40% Trical 815 triticale diet (by weight) or 3) 80% Trical 815 triticale diet. Feed and water were presented *ad libitum*. Pigs started on experiment at 72 kg and were fed 49 d. At the end of each trial all pigs were scanned for backfat (BF) thickness and loin muscle area (LMA). Barrows from one winter and one summer trial were evaluated for meat and fat quality and sensory evaluation of pork. End weights and average daily gain (ADG) were greater during winter than summer (treatment x season interaction, $P < 0.01$) and decreased as triticale inclusion increased ($P < 0.001$). Feed intake was similar. Pigs fed the control diet had the greatest gain-to-feed ratio (G:F); those fed the 80% triticale diet had the least, with pigs fed the 40% triticale diet having intermediate G:F. During summer, pigs fed the control diet had more BF ($P < 0.05$) than those fed the triticale diets. During summer, pigs fed the control diet had the largest LMA; pigs fed the 40% diet had intermediate LMA and those fed the 80% triticale diet had the smallest LMA. Ultimate pH was higher ($P < 0.001$) and percentage loin purge and shear force (kg) were less ($P < 0.05$) during summer than winter. Treatment did not affect sensory evaluation or fatty acid profile of loins. Total monounsaturated fatty acids (MUFA) were greater ($P < 0.05$) and total polyunsaturated fatty acids (PUFA) in loins were less (P

< 0.01) during winter than summer. Replacing corn with triticale in finishing pig diets in hoops slightly decreased growth performance without compromising pork quality.

Key Words: Deep litter swine housing, Triticale, Pork quality

245 United States pork industry pork quality survey. J. Meisinger* and E. Berg, *University of Missouri, Columbia.*

The objective of this survey was to obtain detailed information relative to the measurement and quantification of fresh pork loin quality attributes seen in United States pork processing plants. Questionnaires were sent to nine pork processing companies, representing 97% of the total pork carcasses processed in the United States. Each region of the country was represented. Broad spectrum questions, such as "do you measure objective color?" or "do you measure pH" were asked. If the respondent answered yes, additional, more specific questions were asked to obtain greater detail. The survey revealed that the majority of plants measure pH (100%), objective color (91%), subjective color (82%), exudate (73%), marbling (64%), and blood splash (55%). All of the respondents who measure objective color used a Minolta brand colorimeter to monitor light reflectance readings. Seventy percent of the respondents calibrated to a white plate, while the remaining plants calibrated using two to four calibration tiles. The plants reported an average L^* , a^* , b^* value of 45.61, 6.86, and 1.78, respectively. All respondents measured postmortem loin pH. Various pH probes were used, but the most common was the SFK pH Star probe (33%). Initial pH (< 1h postmortem) was measured by 27% of the plants reporting an average of 6.12, while all plants measured ultimate pH (> 20h postmortem) for an average 5.76. The plants included in this survey responded that 3.34% of loins they fabricate exhibit all three conditions of classic PSE pork (pale, soft, and exudative), reporting a range from 0.1 to 10%.

Key Words: Pork quality, Survey, pH

246 Effect of moisture enhancement on sensory attributes, tenderness, and retail color of beef steaks from the vastus lateralis. P. S. Kuber*¹, A. E. Radunz¹, M. D. Vieson¹, H. N. Zerby¹, S. J. Moeller¹, J. L. Bard¹, A. C. Naber¹, K. M. Brueggemeier¹, G. R. Dunlap¹, and B. L. Gwartzney², ¹The Ohio State University, Columbus, ²National Cattlemen's Beef Association, Centennial, CO.

Fresh beef steaks removed from USDA low Choice (n = 40) and low Select (n = 40) vastus lateralis roasts were measured for the effect of high pressure moisture enhancement on retail color, palatability, and tenderness. Roasts were divided in half by removing one control (CON) steak from the center to determine initial tenderness. Each half received one of two treatments: 1) brine injection (BI) pumped to 110% green weight (2.5% sodium lactate, 0.35% sodium tripolyphosphate and 0.65% sodium chloride); or 2) needle tenderized (NT). Steaks (2.54 cm) were removed from BI and NT roasts for Warner-Bratzler shear-force (7, 14, and 21 d) and sensory analysis (14 d). Subjective (5 d; 5 member panel) and objective color (8 d; L^* , a^* and b^*) were measured daily on steaks under retail display lighting. Overall, BI (3.48 kg) steaks were more tender ($P < 0.0001$) than CON (4.01 kg) and NT (4.80 kg) steaks. Drip and cooking loss were less ($P < 0.0001$) for BI vs NT, and BI vs CON vs NT, respectively, implying both moisture enhancement and intact muscle

improve water retention. Sensory evaluation revealed that BI steaks had more ($P < 0.0001$) initial tenderness and juiciness, sustained tenderness and juiciness, beef flavor intensity and were preferred over NT steaks. Objective color readings reported BI steaks were initially (d 1) darker (L^*), less red (a^*) and less yellow (b^*) ($P < 0.0001$) than NT steaks, however change in L^* and b^* observed between d 1 and 8 readings were less ($P < 0.01$) in BI vs NT steaks implying BI steaks maybe more stable in retail color. Subjective color scores were higher ($P < 0.05$) in BI vs NT steaks, indicating differences in L^* and b^* readings were visible under retail display lighting. These results suggest moisture enhancement may improve sensory attributes, tenderness, moisture retention and stabilize color during retail display.

Key Words: Beef, Moisture enhancement, Palatability

247 Growth performance profile and carcass characteristics of steers fed Optaflexx®. M.T. Van Koevinger^{*1}, M. A. Greenquist², K. J. Vander Pol², G. E. Erickson², T. J. Klopfenstein², and W. J. Platner¹, ¹Elanco Animal Health, Greenfield, IN, ²University of Nebraska, Lincoln.

Crossbred, feedlot steer calves were used in a RCBD to evaluate the effects of Ractopamine HCL (RAC) on growth performance and carcass characteristics when fed for 28 or 42 d prior to slaughter. Within block, cattle were weighed for two consecutive days and randomly assigned to treatment pens at re-implanting (82 d). The study consisted of 4 treatments in 3 blocks, with 7 replications per treatment for a total of 28 pens of 331 cattle (539 kg). The treatment phase consisted of 0 (CON) or 200 mg/hd/d of (RAC) fed for 28 or 42 d prior to slaughter. All steers were projected to be fed and slaughtered at 179 d therefore steers fed RAC for 42 d were on feed an additional 14 d and slaughtered at 193 d. Steers were weighed individually at 0 d, 28 d and 42 d, and pen weighed weekly (0, 7, 14, 21, 28, 35 and 42 d) to determine growth performance profile. Analyses of growth performance data were conducted using a mixed model procedure with pen as the experimental unit. The statistical model included treatment (RAC dose and RAC feeding duration) as the independent fixed effects, and block as a random effect. Initial body weight was used as a covariate. There were no RAC dose x RAC feeding duration interactions ($P > .44$). The main effect of RAC will be discussed. Feeding steers RAC increased ($P < 0.01$) final BW by 8.0 kg (597.8 vs. 605.8 kg), ADG (1.67 vs. 1.91 kg/d) and G:F (0.155 vs. 0.177), while no differences were detected in DMI. Steers fed RAC had greater ($P < .01$) live weight gains at each weekly weight (7-42 d) than CON. Change in weight gain between RAC and CON was quadratic ($P = .02$; $R^2 = 0.97$; $y = -0.0095x^2 + 0.8338x + 0.5314$) with 7.5 kg and 8.5 kg at 28 d and 42 d respectively. RAC increased HCW (382.8 vs. 387.6 kg, $P < 0.01$) by 4.8 kg but had no other effect on carcass characteristics.

Key Words: Ractopamine, Steer, Growth

248 Evaluating the tenderness of beef chuck and round muscles enhanced with ammonium hydroxide and salt. A. Hamling* and C. Calkins, University of Nebraska, Lincoln.

Previous research has shown that beef treated with ammonium hydroxide as a processing aid to reduce or eliminate potential pathogens is more

tender than untreated beef. The tenderness improvement is the result of pH adjustment that occurs as a consequence of the treatment process. The objective of this study was to evaluate the effects of such pH adjustment on tenderness of beef chuck and round muscles. A randomized, complete block design of 4 treatments and 3 muscles with 3 replications was used, with a total of 15 subprimals per treatment. Treatments included a 0% (CON), 15% (T15), 22.5% (T22) and 30% (T30) target pump. The triceps brachii (TB), biceps femoris (BF), and rectus femoris (RF) were studied. Muscles were injected with a solution of ammonium hydroxide and sodium chloride (patent pending technology from Freezing Machines, Inc.) Individual steaks were cut to a thickness of 2.5 cm, vacuum packaged in trays, and frozen. Thaw loss, cooking loss, pH, and Warner-Bratzler shear force were determined. Steaks were cooked to an internal temperature of 70 C. Shear force decreased as the target pump percentage increased for all muscles ($P < 0.05$): TB = 4.07, 3.58, 3.27, and 2.75 kg; BF = 4.02, 2.67, 2.38, and 1.97 kg; RF = 4.35, 3.35, 3.13, and 2.95 kg for CON, T15, T22, and T30, respectively. In all cases, there were no shear force differences between T15 and T22 ($P > 0.05$). As percentage pump increased, pH increased. The ultimate pH was strongly related to shear force ($r = 0.70, 0.80, \text{ and } 0.55$ for TB, BF, and RF, respectively). Total weight losses (thaw loss + cooking loss) were 1.5 to 7% greater in the treated samples ($P < 0.05$) than the CON samples, but were not always different among the treated samples. Cooking times were equal among treatments for the TB and RF and 3 to 8 min shorter than the CON in the BF. These data suggest adjusting pH in beef with ammonium hydroxide can increase tenderness in muscles from the beef chuck and round. Any level of treatment was beneficial, with the greatest shear force benefit occurring in muscle pumped to 30% with ammonium hydroxide and salt.

Key Words: Beef, Tenderness, Enhancement

249 Off-flavor mitigation in fed and non-fed cow meat through manipulation of bitter taste receptors. D. Moss* and C. Calkins, University of Nebraska, Lincoln.

Past approaches to off-flavor in beef were either to prevent the troublesome compound or to counteract the response (i.e. drown it out by another taste). The objective of this study was to explore new ways of managing off-flavor by blocking bitter perception in taste cells. Five fed and five non-fed cow strip loins were obtained and randomly assigned to one of five replications. Five steaks were removed from the anterior end of each strip loin and randomly assigned to one of five treatments: a control or one of four commercial bitter blockers. All treatments were represented in each strip loin. For distribution purposes, each treatment was combined with water such that addition of 1% of steak weight would deliver the industry recommended level, 0.05%-0.25%, in the final product. Steaks were vacuum packed and tumbled with 1% water or 1% of the appropriate bitter blocker for 15 min. After equilibrating for 24 h, samples were frozen, stored at -20°C, thawed, cooked, and served to a seven-member, trained taste panel. Steaks were broiled to an internal temperature of 70°C and portioned into 1.27 x 1.27 cm cubes. A three-minute intermission was observed between each sample served. Overall off-flavor scores were generally low; as a result there were no significant treatment effects for reducing off-flavor. Treatments did not contribute to off-flavor ratings, except for one ($P = 0.02$ versus the control). If off-flavors were present, panelists were asked to identify them. Between 30-40% of cow meat samples were characterized as having metallic and sour notes and 10-20% of the samples were identified as

having rancid, bloody, and bitter flavor notes. Non-fed cow meat more frequently had bloody and fatty off-flavor notes than meat from fed cows ($P=.03$ and $.07$, respectively). It appears that bitter blockers do not deteriorate sample flavor. However, samples that possess a greater

amount of initial off-flavor are needed to truly evaluate the mitigation properties for bitter blockers.

Key Words: Off-flavor, Bitter blocker, Cow beef

Nonruminant Nutrition

250 Comparative efficacy of commercial dry mold inhibitors as determined by carbon dioxide evolution. M. Burke*, T. Truong, A. Lamptey, S. Moore, and V. Sewalt, *Kemin, Des Moines, IA.*

Mold inhibitors ensure the nutritional quality of feeds. The efficacy of five commercial dry mold inhibitors was established in two experiments. Products included dry calcium propionate (CaP) and four products made with organic acids on a dry carrier (AOC), coded based on total acid content: AOC48, AOC42, AOC34 and AOC23, containing 48, 42, 34, and 23% total acids, respectively. In Experiment 1, AOC42 was compared with AOC23. In Experiment 2, AOC48, AOC42, AOC34 and CaP were compared. In each experiment mash swine feed was treated in triplicate with 1 and 2 kg/MT of each product. Treatments were arranged as 2x2 (Exp. 1) or 4x2 (Exp.2) factorials with 2 or 4 products and 2 application rates. Untreated controls were also evaluated in triplicate. Samples were held at 25°C and product efficacy was established by monitoring CO₂ evolution and calculating the days-to-midpoint CO₂ (approx. 10%) using polynomial regression. Product characteristics such as concentration of organic acid, propionic acid, pH, degree of buffering and the concentration of free (undissociated) acid were determined. In Experiment 1, AOC42 was more effective ($P<0.001$) in delaying days-to-midpoint CO₂ (11.1 d) than AOC23 (8.3 d). The magnitude of the difference in efficacy between the two application rates was also larger ($P<0.001$) for AOC42 (9.2 vs 12.9 d) than for AOC23 (7.5 vs 9.1 d) (product x application rate interaction). In Experiment 2, each AOC product showed significantly slower ($P<0.05$) CO₂ evolution (9.8 to 12.4 d to reach midpoint) than CaP (8.4 d). Strong positive correlations existed between efficacy and concentrations of free (undissociated) and total acid. Negative correlations were found between pH and percent free acid and between pH and efficacy. Overall, the AOC products outperformed CaP as determined by reduced CO₂ evolution. Although the most effective AOC product was also the most corrosive, the correlation between efficacy and corrosiveness was low, allowing for product selection targeting effective mold control with minimal risk of metal corrosion.

Key Words: Mold inhibition, Propionic acid, Calcium propionate

251 The effects of dietary glutamine, glycine, and salt concentration on nursery pig growth performance. C. N. Groesbeck*, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, J. L. Nelssen, and R. D. Goodband, *Kansas State University, Manhattan.*

A total of 216 pigs (5.6 kg BW, 21 ± 2 d of age) were used in a 14-d growth assay to evaluate the effects of feeding added salt (0.38% in addition to the 0.35% already in the diet) or a 0.70% addition of a 50% glutamine:50% glycine (Glu/Gly) blend as a substitute for spray-dried animal plasma (SDAP). Pigs were blocked by weight and randomly allotted to one of six dietary treatments. Diets included a corn-soybean

meal-based negative control, a positive control containing 5% SDAP, and high crystalline amino acid diets arranged in a 2 x 2 factorial with main effects of Glu/Gly (none or 0.70%) and added salt (none or 0.38). The crystalline amino acids replaced the essential amino acids provided by SDAP. From d 0 to 7, ADG and ADFI were greater ($P<0.05$) for pigs fed the positive control diet compared with all other treatments. Pigs fed the high crystalline amino acid diets with or without added Glu/Gly and salt had improved ($P<0.05$) G:F compared with pigs fed the negative and positive control diets. From d 7 to 14, pigs fed the positive control diet had greater ($P<0.05$) ADG compared with pigs fed the negative control; however, it did not differ from pigs fed the four added Glu/Gly or salt treatments. Pigs fed the positive control diet had greater ($P<0.05$) ADFI and G:F compared with all other treatments. From d 0 to 14, pigs fed the positive control diet had greater ($P<0.05$) ADG and ADFI compared with pigs fed the negative control diet and greater ($P<0.05$) ADFI compared with all other treatments. Adding SDAP to the diet improved growth performance of nursery pigs, while adding salt above the 0.35% already provided in the diet and adding Glu/Gly to the synthetic amino acid diets did not influence growth performance. However, pigs fed diets containing high levels of synthetic amino acids had intermediate ADG and improved G:F to SDAP and negative control.

Key Words: Glutamine, Glycine, Sodium

252 Immunomodulatory effects of a Bacillus-based direct-fed microbial and antibiotics on the cytokine profile of nursery pigs.

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A total of 288 pigs were weaned to a wean-to-finish facility and blocked by BW to determine the effect of a *Bacillus*-based direct-fed microbial (DFM) and antibiotic supplementation on the cytokine profile of blood monocytes and lymphocytes. Dietary treatments were arranged as a 2 x 2 factorial with two levels of antibiotic (0 and 50 g carbadox/ton of feed during Phase 1 and 2, and 0 and 400 g oxytetracycline/ton of feed during Phase 3) and two levels of DFM (0 and 0.25%). Peripheral blood mononuclear cells (PBMC) were isolated from 4 pigs/treatment on d 20 and d 42 after weaning and cytokine production was elaborated by stimulating with lipopolysaccharide (LPS) for production of tumor necrosis factor- α (TNF) and IL-1 and with concanavalin A for production of IL-4. An additional plasma sample was obtained to measure circulating concentrations of TNF. Production of IL-1 from PBMC isolated from pigs fed DFM decreased ($P<0.05$) from d 20 to d 42 post-weaning, whereas production of IL-1 by pigs not provided DFM was similar across the two days (DFM x day, $P<0.05$). Conversely, production of IL-4 by PBMC from pigs fed DFM did not change from d 20 to d 42 post-weaning, whereas IL-4 production by PBMC from unsupplemented pigs decreased ($P=0.05$) from d 20 to d 42 (DFM x day, $P<0.05$).

Plasma concentrations of TNF decreased ($P < 0.05$) from d 20 to d 42 in pigs fed antibiotics, but remained similar across the two days in pigs not provided antibiotic supplementation (antibiotic x day, $P = 0.10$). Production of TNF from unstimulated PBMC isolated from pigs fed the four treatments was not different on d 20 after weaning; however, PBMC from pigs fed antibiotics had lower ($P < 0.05$) production of TNF on d 42 after weaning than pigs fed the control diet, whereas production of TNF by cells from pigs fed DFM or DFM+antibiotic did not differ from control or antibiotic supplemented pigs (DFM x antibiotic x day, $P = 0.09$). These data indicate that both DFM and antibiotic supplementation alters the cytokine profile of nursery pigs by decreasing the production of proinflammatory cytokines (IL-1 and TNF) at the end of the nursery phase.

Key Words: Swine, Bacillus, Immunity

253 Bioavailability of zinc-amino acid chelates to zinc sulfate in broiler chickens. S. K. Kommera*, R. D. Mateo, C. Lin, and S. W. Kim, *Texas Tech University, Lubbock*.

Relative bioavailability of zinc-glycine (10.93% Zn, Albion-Advanced Nutrition) and zinc-methionyl glycine (20.38% Zn, Albion-Advanced Nutrition) to zinc sulfate (35.7% Zn) was determined using 447, 1 d old, broiler chickens. Fifteen birds were killed at d 0 and ground for carcass sampling. Remaining 432 birds were allotted to four dietary treatments: NC (without Zn supplement), PC (with 40 ppm Zn from ZnSO₄), TA (with 40 ppm Zn from Zn-methyl glycine), and TB (with 40 ppm Zn from Zn-glycine). There were six replicates per treatment with initially 18 birds per stainless steel brooder cage with the heater. Birds had feed and water ad libitum during 21 d feeding period. Body weight and feed intake were measured on d 1, 3, 5, 7, 14, and 21. Excreta were collected on d 1, 3, 5, 7, 14, and 21 and dried under 60°C in a drying oven. Groups of three birds were randomly selected and killed at d 1, 3, 5, 7, 14, and 21, ground together for each day, sampled, and analyzed for Zn. The ADG of birds were 27.1, 35.6, 36.2, and 38.4 for NC, PC, TA, and TB, respectively during the wk 3 and 26.7, 29.4, 29.9, and 29.8, respectively for the entire 3 wk period. However, ADG were not different among the treatments. Content of Zn (mg) in bird carcass was the same among the treatments until d 3. However, Zn content was smaller in NC ($P < 0.05$) than other treatments after d 5. There were no differences ($P > 0.05$) in Zn content among PC, TA, and TB. On d 3, Zn contents were 0.87, 1.08, 0.87, and 0.64 whereas they were 10.78, 16.27, 15.85, and 15.61 on d 21 for the NC, PC, TA, and TB, respectively. Digestibility of supplemented Zn of the TA and TB was higher ($P < 0.05$) than the PC during the entire 3 wk period. Digestibilities of Zn were 49, 56, and 55% for the PC, TA, and TB, respectively. Collectively, Zn from Zn-glycine and Zn-methyl glycine is more bioavailable than Zn from inorganic source by broiler chickens during the first 3 week of their age. Zn from Zn-glycine and Zn-methyl glycine was equally bioavailable to broiler chickens.

Key Words: Zinc amino acid chelate, Broilers, Bioavailability

254 Supplemental effects of selenium enriched vegetables in broiler diets on growth performance and tissue selenium levels.

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This study was to determine the selenium (Se) availability from Se enriched garlic and cabbages to broiler chickens. Selenium enriched garlic and cabbages were produced (18.5 and 101.5 ppm Se, respectively) from hydroponics. Conventional and Se enriched garlic and cabbages were dried and ground to be used as supplements in broiler diets depending on the dietary treatments. One hundred broiler chickens at d 1 of age were allotted to four dietary treatments: NC (Cabbage + Garlic); PC (Cabbage + Garlic + Selenomethionine, 0.5 ppm added Se); GS (Cabbage + Se-enriched garlic, 0.5 ppm added Se) and CS (Garlic + Se-enriched cabbage, 0.5 ppm added Se). Birds were fed the experimental diets for 4 weeks and slaughtered for sampling tissues and blood. Tissues included white muscle, dark muscle, liver, and feather. All the excreta were collected weekly, dried, and ground for the chemical analysis. Total Se in liver, white muscle, dark muscle, feather, and excreta were measured. Bird weight gain and feed intake were also measured weekly. The PC had the highest ($P < 0.05$) ADG (54.1 g/d) among all treatments. The GS (44.2 g/d) had higher ($P < 0.05$) ADG than the NC (35.0 g/d) and ADG of the NC and CS (38.1 g/d) did not differ ($P > 0.05$) during the wk 4. Total liver Se content of the PC (0.876 ppm) was the highest ($P < 0.05$). The CS (0.693 ppm) and the GS (0.627 ppm) had higher ($P < 0.05$) total liver Se than the NC (0.514 ppm). The PC had the higher ($P < 0.05$) Se content in white muscle, dark muscle, and feather than other treatments. Contents of Se in white muscle, dark muscle, and feather were not different ($P > 0.05$) among the NC, CS, and GS. This study indicates that Se from Se enriched vegetables is not accumulative in muscles and feathers as parts of tissue proteins but may be better used in liver as a part of enzymes.

Key Words: Selenium-enriched garlic, Selenium-enriched cabbages, Broilers

255 Effects of protein source and fat level on pancreatic enzyme activity and gene expression in early-weaned pigs. T. Buhay*, S. Carter, R. Cueno, M. Lachmann, J. Park, and J. Schneider, *Oklahoma State University, Stillwater*.

As part of a continuing study to examine the effects of CP source on ME (fat) utilization in early-weaned pigs, the effects on pancreatic enzyme activity and gene expression (GEx) were determined. A total of 80 pigs (avg 5.2 kg BW, 18 d) were allotted to four dietary treatments (5 pigs/trt) in a 2 x 2 factorial, with two CP sources (soy protein concentrate, SPC vs. spray-dried porcine plasma, SDPP) and two ME levels (3,323 vs. 3,523 kcal/kg). SDPP replaced SPC on a digestible Lys basis and ME level was adjusted using soybean oil. All diets had equal amounts of corn, soybean meal, dried whey, lactose, and fishmeal. One pig/trt was euthanized on d 0, 3, 7, and 14. The pancreas and small intestine were excised, intestinal contents (chyme) collected, and intestinal morphology determined. RNA was extracted from the pancreas and enzyme GEx was quantified with real-time PCR. Enzyme activity of the pancreas and chyme, and immunoglobulin G (IgG) in chyme were quantified. Villous height and villous height: crypt depth were increased ($P < 0.02$), and chyme IgG was higher ($P < 0.01$) in pigs fed SDPP vs. those fed SPC on d 3, 7, and 14. Amylase GEx increased ($P < 0.01$) from d 0

to 14, and was higher ($P < 0.03$) in pigs fed SDPP on d 3, 7, and 14. There were no CP source effects ($P > 0.10$) on lipase and trypsinogen GEx, but they were numerically higher in pigs fed SDPP. Lipase activity in pancreas and chyme decreased numerically from d 0 to 14, but activity in chyme tended to be higher ($P < 0.09$) in pigs fed SDPP on d 7 and 14. Amylase activity in pancreas and chyme increased numerically from d 3 to 14, and activity in chyme was higher ($P < 0.03$) in pigs fed SDPP on d 14. Increasing the fat level in the diet did not affect pancreatic enzyme activity and GEx. Similar to previous studies, SDPP increased villous height and villous height: crypt depth. The increase in pancreatic enzyme activity and gene expression may be another mechanism by which SDPP improves growth performance of early-weaned pigs.

Key Words: Pigs, Protein, Pancreatic enzymes

256 Impact of weekly random out-of-feed events and feed particle size on grow-finish pig performance. M. Brumm^{*1}, S. Colgan¹, and K. Bruns², ¹University of Nebraska, Concord, ²South Dakota State University, Brookings.

Two hundred forty barrows (initial wt 23.7 kg) were used to evaluate the effect of repeated out-of-feed (OOF) events and diet particle size on performance to slaughter. There were 15 pigs (0.69m²/pig), 1 bowl drinker, and 1 2-hole feeder per pen in a fully slatted, naturally ventilated wean-to-finish facility. There were 4 pens per treatment combination in a 2 x 2 factorial design. Diets were corn-soybean meal based in meal form. Treatments were diet particle size (coarse = 1266 microns; medium = 1019 microns) and OOF events which occurred never or once weekly on a random day for 16 wk. Out-of-feed was accomplished by closing the feed delivery mechanism on the feeder from 1200 hr to 0800 hr. There were no interactions between particle size and OOF events. For the first 53 d, OOF versus never resulted in reduced ADG (805 vs 872 g/d; $P < 0.001$) and ADFI (1.873 vs 2.005 kg/d; $P = 0.033$) respectively. There was no difference ($P > 0.10$) between OOF and never in ADG or ADFI for the subsequent 56 d period. Overall, OOF reduced ADG (832 vs 867 g/d; $P = 0.008$) and ADFI (2.417 vs 2.506 kg/d; $P = 0.023$) compared to never. When corrected for final weight, there was no difference ($P > 0.10$) in 10th rib back fat or loin eye area between OOF and never. There was no effect ($P > 0.10$) of particle size on overall ADG, backfat depth or loin eye area at slaughter. However, pigs fed coarse diets had a lower overall G:F compared to pigs fed medium diets (.340 vs .351; $P = 0.002$) respectively. There was no effect ($P > 0.10$) on average biweekly individual pig lesion score (scale 0 to 4 with 0 being no observed lesions/scratches and 4 being 12+ small/red or 6+ large/red lesions/scratches) from either treatment. These results suggest that pigs adjust to repeated, random weekly OOF events. The penalty for repeated OOF events is an initial reduction in ADG and ADFI which is not compensated for later in the growth process, while the penalty for coarser feed particle size is poorer G:F with no impact on ADG during the entire growth process.

Key Words: Pigs, Feed availability, Particle size

257 Digestibility of phosphorus in field peas by growing pigs.

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An experiment was conducted to measure the apparent (ATTD) and true (TTTD) total tract digestibility of P in field peas either without or with the addition of 500 FYT of microbial phytase (Rhonozyme). Six pigs were placed in metabolism cages and allotted to three diets in a repeated 3 x 3 Latin square design. The three dietary treatments were field peas, field peas with phytase, and a P-free diet. The P-free diet was used to measure endogenous losses of P from the pigs which allowed for the calculation of TTTD. Total collections of urine and fecal material were performed during 5-d periods following a 7-d adaptation period to the diet. Results of this experiment showed that the ATTD and TTTD of P in field peas without microbial phytase (55 and 60.8%, respectively) were lower ($P = 0.01$) than in field peas with microbial phytase (70.0 and 75.6%, respectively). Likewise, P retention increased ($P = 0.001$) from 7.09 g to 9.78 g/five d with the addition of microbial phytase to the diet. On a percentage basis, the retention of P increased ($P = 0.001$) from 54.9 to 69.9% with the addition of phytase to the diet. The endogenous loss of P was estimated at 207 mg per kg DMI. The ATTD for Ca in field peas was 72.8 and 76.6% in diets without and with field peas, respectively. These values were not different. The absorption of Ca was not influenced by phytase (10.3 and 10.9 g/five d without and with phytase, respectively). However, the retention of Ca increased ($P = 0.001$) from 8.81 to 10.36 g/five d with the addition of phytase to the diet. On a percentage basis, retention of Ca increased ($P = 0.001$) from 62.5 to 73.8% with the addition of phytase to the diet. The addition of microbial phytase to field peas also reduced ($P = 0.001$) the excretion of P in the feces (from 5.77 to 4.09 g/five d). It is concluded that the P in field peas has a relatively high digestibility and that this digestibility may be improved by microbial phytase.

Key Words: Field peas, Pigs, Phosphorus

258 Evaluation of the performance response in maternal line barrows using a ractopamine step-up feeding program. G. Pelger^{*1}, S. Carr¹, P. Matzat¹, and D. Mechler², ¹Elanco Animal Health, Greenfield, IN, ²Suidae Health and Production, Algona, IA.

The purpose of this study was to measure the improvement due to ractopamine (RAC; Paylean, Elanco Animal Health, Greenfield, IN) step-up program in maternal line barrows in a commercial finishing barn. Thirty-six pens of 20-22 barrows were weighed, blocked by weight and then assigned to one of two treatments: Treatment 1-RAC (5 ppm for 21 days followed by 10 ppm for 14 days) or Treatment 2-Negative Control (0 ppm for 35 days). Pens were weighed on Day 0 and Day 35 to determine beginning weight, ending weight and average daily gain (ADG). Feed issuance and weigh backs were recorded to determine average daily feed intake (ADFI) and gain:feed ratio (G:F). Feed samples were saved to determine actual amount of RAC in the feed. On Day 35, pigs were sent to a food company in the Midwest for slaughter on Day 36. Hot carcass weight (HCW) and Percent Lean (% Lean) were recorded for each carcass. Statistical analysis was completed using Proc GLM (SAS Institute, Cary, NC). All feed assays returned within acceptable limits for RAC inclusion (or exclusion). Treatment 1 and 2 started the study with the same average animal weight. RAC improved

ending weight by 3.4 kg ($p=0.003$). ADG increased by 12% ($p=0.001$) during the 35-day period due to RAC. There was no difference between Treatment 1 and 2 for ADFI. G:F was improved in Treatment 1 ($P=0.001$). HCW increased by 7.4 lbs ($P=0.001$) and % Lean improved by 1.4% ($P=0.001$). No differences between treatments were seen in dead or removed pigs during the study. RAC decreased the number of "lights" (carcasses weighing less than 75.9 kg, $P=0.003$). Results of this study were consistent with previous studies looking at RAC Step-Up, showing a 12% improvement in ADG and 11% improvement in G:F over the 35 day period.¹ The previous study¹ also showed a 5% improvement in HCW, and this study also showed a similar improvement (4.2%).

¹Armstrong et al. (2005) Evaluation of Paylean Step-Up Use Programs in Commercial Pigs. *J Swine Health Prod* 13:66-71.

Key Words: Ractopamine, Performance

259 Evaluation of the performance response in different genotypes to ractopamine supplementation. G. Pelger¹, T. Armstrong¹, C. Parks^{*1}, P. Matzat¹, N. Williams², and D. Mechler³, ¹*Elanco Animal Health, Greenfield, IN*, ²*PIC, Franklin, KY*, ³*Suidae Health and Production, Greenfield, IN*.

The purpose of this study was to measure the improvement due to ractopamine (RAC, Paylean, Elanco Animal Health, Greenfield, IN) and determine the difference in response between two genotypes in a com-

mercial finishing barn. Forty pens of 20-22 pigs were weighed, blocked by weight and then assigned to one of two treatments within genotype: Treatment 1-RAC (10 ppm for 28 days) or Treatment 2-Negative Control (0 ppm for 28 days). Barrows and gilts were analyzed separately within genotype 280 (10 pens each), while only barrows were on test for genotype 337 (20 pens). Pens were weighed to determine beginning weight, ending weight, weekly weight gain and average daily gain (ADG). Feed issuance and weigh backs were recorded to determine average daily feed intake (ADFI) and gain: feed ratio (G:F). Feed samples were saved to determine actual RAC inclusion. After Day 28, pigs were sent to a food company in the Midwest for slaughter. Hot carcass weight (HCW), Loin Depth (LD), 10th rib Backfat (BF) and Percent Lean (% Lean) were recorded for each carcass. Four pens were removed from the analysis due to discrepancies in pig inventory. Statistical analysis was completed using Proc GLM (SAS Institute, Cary, NC). All feed assays returned within acceptable limits for RAC inclusion (or exclusion). No differences between treatments were seen in dead, removed or "light" pigs during the study (Data not shown). There were no significant gender interactions ($P<0.05$) for any of the measured parameters so data were analyzed for main effects within genotype. RAC improved ending weight ($P=0.044$, 337; $P=0.003$, 280), ADG ($P=0.001$, 337; $P=0.001$, 280), G:F ($P=0.001$, 337; $P=0.001$, 280), LD ($P=0.002$, 337; $P=0.01$, 280), %Lean ($P=0.001$, 337; $P=0.002$, 280) and reduced BF ($P=0.0001$, 337; $P=0.004$, 280) in both genotypes. Because both genders were not represented in each genotype, analyses could only be completed within genotype (280) or within gender (barrows). Although specific analyses across genotypes could not be completed in this study, the percent response due to RAC appears similar in both genotypes, with 15-20% improvement in ADG and G:F during the RAC feeding period.

Key Words: Ractopamine, Performance, Pigs

Ruminant Nutrition

260 Rumen digestibility of diets containing wheat midds, soybean hulls and corn gluten feed. P. Walker^{*1}, K. Earing², and J. Ringler², ¹*Illinois State University, Normal*, ²*University of Kentucky, Lexington*.

Four ruminally fistulated steers were used in a 4 x 4 Latin square, in situ trial to evaluate the rumen digestibility of a wheat midd-soybean diet (D1), a corn gluten feed-shelled corn diet (D2), a corn gluten feed-soybean diet (D3) and corn gluten feed (D4). Steers were fed water and grass hay ad libitum. Treatments were fed once daily at 1600 h at 1.0% BW (wet wt. basis). Experiment periods were 17d with a 14-d adaptation period. On d 15, 3 Dacron bags containing 10g:bag were placed into the rumen of each steer at 0, 12, 24, 36, 48, 60 and 66h. All bags were removed at 72 h. Each time Dacron bags were placed into the rumen, fluid was analyzed for pH. Feed samples were analyzed for ether extract (EE), OM, N, NDF, ADF, cellulose (CEL), and ash. CP and HC were determined by calculation ($N\% \times 6.25 = CP$ and $NDF-ADF = HC$). D1 contained 14.7% CP, 2.8% EE, 52.8% NDF, 25.8% ADF, 27.0% HC and 23.3% CEL. D2 contained 15.2% CP, 4.4% EE, 32.6% NDF, 8.7% ADF, 23.9% HC and 7.4% CEL. D3 contained 14.9% CP,

3.4% EE, 60.8% NDF, 36.8% ADF, 24.0% H and 34.5% CEL. D4 contained 24.0% CP, 4.3% EE, 35.5% NDF, 12.1% ADF, 23.4% HC and 7.1% CEL. Rumen pH was similar between D1, D2, D3 and D4 ranging from 6.6 to 6.8. Rumen disappearance at all h post-placement of all analytes was lower ($P<0.05$) for D3 than D1, D2 and D4. By 24 h N disappearance was greater ($P<0.05$) for D4 than D1, comparing 60.59% and 28.16%. By 48 h OM disappearance differed ($P<0.05$) with $D2>D4>D1 = D3$ comparing 56.70%, 50.41%, 43.26%, 39.25% but the order of N disappearance was $D4>D2>D3 = D1$ comparing 72.53%, 56.51%, 30.39% and 38.79%. By 72 h rumen disappearance for N and OM was lower ($P<0.05$) for D3 than D1, D2 or D4. Rumen disappearance of OM ($x = 69.85\%$), ASH ($x = 90.45\%$) and N ($x = 79.98\%$) was greatest for D4 and D2 by 72 h. No difference ($P>0.05$) in CELL or ADF disappearance by 72h was observed between treatments. The diet containing corn gluten feed and soybeans resulted in lower rumen digestibilities than the other diet combinations. Corn gluten feed alone resulted in similar rumen digestibilities as did a diet containing corn gluten feed and shelled corn.

Key Words: Corn gluten feed, Soybean hulls, Rumen disappearance

261 Effects of supplemental RDP versus increasing amounts of supplemental RUP on ruminal characteristics and site and extent of digestion in lambs fed a low-quality forage. R. L. Atkinson*, C. D. Toone, and P. A. Ludden, *University of Wyoming, Laramie*.

Four cannulated suffolk wether lambs (34.5 ± 2.04 kg) were used in a 4×4 Latin square designed experiment to compare the value of supplemental RDP versus increasing amounts of supplemental RUP on ruminal characteristics and site and extent of digestion in lambs consuming a low-quality forage diet. Lambs were fed a basal diet of crested wheatgrass hay (4.9% CP) for ad libitum consumption, plus one of four protein supplements: isolated soy protein fed to meet estimated RDP requirements (CON), or corn gluten meal (RUP) fed at 50, 100, or 150% of the supplemental N provided by CON (C50, C100, and C150, respectively). Intakes of OM, NDF, ADF and N were not affected ($P = 0.09$) by protein degradability; however, OM, N, and ADF intakes increased linearly ($P = 0.05$) and NDF intake tended ($P = 0.07$) to increase linearly with increasing RUP. True ruminal OM digestion and ruminal digestibilities of NDF and ADF were not affected ($P = 0.12$) by treatment. However, true ruminal N digestibility was greater ($P = 0.03$) for CON lambs vs. C100, and decreased linearly ($P < 0.01$) with increasing RUP. Consequently, ruminal ammonia concentrations were greater ($P = 0.002$) in CON vs. C100 lambs, and decreased ($P = 0.02$) with increasing RUP. Microbial N flows were not affected ($P = 0.12$) by increasing RUP, and were similar ($P = 0.25$) between CON and C100. Likewise, neither ruminal urease activity ($P = 0.13$) nor microbial efficiency ($P = 0.31$) were affected by treatment. Total tract OM, NDF, and ADF digestibilities were greater ($P = 0.05$) for C100 lambs compared to CON lambs, but tended ($P = 0.08$) to be greater in C100 than for C50 or C150 lambs. Likewise, total tract N digestibility was greater ($P = 0.03$) in C100 than in CON lambs, but increased linearly ($P < 0.001$) with increasing RUP. When fed on an iso-N basis, supplemental RUP may serve as a sustained source of recyclable N, resulting in minimal impact on microbial growth and subsequent utilization of low quality forage.

Key Words: Ruminally undegradable protein, Urease activity, N recycling

262 Effects of ruminal protein degradability and frequency of supplementation on ruminal characteristics and site and extent of digestion of lambs fed a low-quality forage. R. L. Atkinson*, C. D. Toone, and P. A. Ludden, *University of Wyoming, Laramie*.

Four cannulated suffolk wether lambs (34.5 ± 2.04 kg) were used in a 4×4 Latin square designed experiment to examine the effects of ruminal protein degradability and supplementation frequency on site and extent of digestion in lambs consuming a low-quality forage diet. Wethers were fed a basal diet of mature crested wheatgrass hay (4.2% CP) for ad libitum consumption plus one of four supplements: 1) a high RDP supplement formulated to meet estimated RDP requirements assuming a microbial efficiency of 11% of TDN, provided daily (RDP-D), 2) the high RDP supplement provided on alternate days (RDP-A), 3) a high RUP supplement fed on an iso-N basis to RDP-D, provided on alternate days (RUP-A), or 4) a 50:50 mixture of the RDP and RUP supplements, provided on alternate days (MIX-A). Intakes of OM, N, NDF, or ADF were not affected ($P = 0.17$) by protein degradability or supplementation frequency. True ruminal OM ($P = 0.001$) and N ($P = 0.04$)

digestibilities were greater for alternate-day supplemented lambs, with MIX-A lambs exhibiting the greatest digestibilities. Likewise, ruminal digestibilities of NDF and ADF were greater ($P = 0.004$) for alternate-day supplemented lambs, with MIX-A lambs having the greatest ($P = 0.03$) fiber digestibility. However, alternate-day supplemented lambs also had the lowest ($P = 0.001$) ruminal ammonia concentrations, wherein RUP-A lambs exhibited the lowest ($P = 0.001$) and most stable concentrations. However, ruminal urease activity was not affected ($P = 0.33$) by treatment. Protein degradability did not affect ($P = 0.71$) microbial N flows, but RDP-D lambs tended ($P = 0.06$) to have greater microbial N flows than lambs supplemented on alternate days. Alternate day protein supplementation with RUP may improve digestibility in lambs consuming low-quality forage, which may be related to decreased fluctuation in ruminal ammonia concentrations as a result of greater endogenous N recycling.

Key Words: Ruminally undegradable protein, Urease activity, N recycling

263 Utilization of kura clover-reed canarygrass silage vs. alfalfa silage by lactating dairy cows. K. Kammes*, G. Heemink, K. Albrecht, and D. Combs, *University of Wisconsin, Madison*.

Twenty lactating Holstein cows were used in a replicated cross-over design to compare dry matter intake (DMI) and milk production from diets containing kura clover (*Trifolium ambiguum* Bieb.)-reed canarygrass (*Phalaris arundinacea* L.) or alfalfa (*Medicago sativa* L.). Forages were harvested, ensiled in horizontal plastic bags, and allowed to ferment at least 60 days prior to start of the feeding experiment. The NDF concentrations of kura clover-reed canarygrass silage (KRS) and alfalfa silage (AS) were 47.3% and 37.3%, respectively. KRS silage was approximately 40% kura clover and 60% reed canarygrass. Treatments were TMR formulated with either: 1) 60% of total DMI as AS or 2) 60% of total DMI as KRS. Experimental periods were 28 d with the first 14 d for diet adaptation and the last 14 d for measurement of intake and milk production. Milk samples were collected four times from both AM and PM milkings during the last 7 d of each period. Dry matter intake was higher ($P < 0.05$; 24.2 kg vs 22.9 kg) and 4% FCM tended to be higher ($P < 0.1$; 32.8 kg vs 30.9 kg) for cows fed AS than KRS. Milk fat (3.60%) and milk true protein (3.16%) did not differ due to treatment. Milk urea nitrogen content was higher ($P < 0.01$) when cows consumed AS (16.5 mg/dl) than KRS (13.4 mg/dl). Cows consumed more NDF from forage (6.5 kg vs 5.4 kg) and more digestible NDF from forage (4.2 kg vs 2.4 kg) when fed KRS diets than AS diets. Although KRS diets were higher in NDF than AS diets, cows were able to produce similarly when fed diets containing approximately 60% forage.

Key Words: Dairy, Forage utilization, Milk production

264 Glycerol from soy diesel production as a feed supplement to lactating dairy cows. P. Linke*, A. Hippen, K. Kalscheur, and D. Schingoethe, *South Dakota State University, Brookings*.

Glycerol, a co-product of the bio-diesel industry, has shown promise as an effective preventative and treatment for lactational ketosis in fresh

dairy cows. The high cost of this product, however, has prevented its use as a feed supplement in dairy cow diets. Increased production of bio-diesel from soybean oil may decrease the cost of glycerol allowing this to be considered as an energy supplement for dairy cattle. This experiment was designed to examine the suitability of glycerol as an energy supplement in the lactation diet of dairy cows. Six primiparous Holstein and six primiparous Brown Swiss cows (192 DIM; SD \pm 150), were assigned to one of three diets in a Latin square design with four week periods. The diets were: 1) Control (C) diet containing no glycerol; 2) Low glycerol (G1), the control diet with 0.5 kg of glycerol; and 3) High glycerol (G2), the control diet with 1.0 kg of glycerol. Milk production and DMI were recorded daily. Milk samples were collected at each milking for three consecutive days at the end of each period for determination of composition. Production results were as follows: DMI (19.0, 18.1, and 18.8 kg/d), milk yield (28.8, 29.7, and 29.8 kg/d), and 4% FCM (27.5, 28.3, and 28.9 kg/d) were not changed ($P > 0.10$) by glycerol supplementation for C, G1, and G2, respectively. Feed efficiency was increased by glycerol supplementation (1.46, 1.59, and 1.60 kg FCM/kg DMI; $P < 0.05$) Milk composition was not changed except MUN concentrations were decreased with the addition of glycerol (15.6, 14.8, and 14.4 mg/dl; $P < 0.01$) Breed differences were observed for fat (3.94 and 3.50%) and protein percentage (3.37 and 3.07%) as well as MUN (16.53 and 13.34 mg/dl) for Brown Swiss and Holstein, respectively ($P < 0.05$). There was no interaction of breed and treatment for any parameters measured. In summary, the addition of glycerol to lactation diets increased the efficiency of production of fat-corrected milk and improved dietary protein utilization as evidenced by decrease concentrations of urea nitrogen in milk of cows fed glycerol.

Key Words: Glycerol, Dairy cows, Lactation

265 The effect of fatty acid source and forage source on trans-C18:1 and conjugated linoleic acid production by ruminal microbes in batch culture. W. Buckles^{*1}, A. AbuGhazaleh¹, G. Apgar¹, K. Jones¹, and K. Griswold², ¹*Southern Illinois University, Carbondale*, ²*Pennsylvania State University, Lancaster*.

Previously, docosahexaenoic acid (DHA) was identified as the active component in fish oil that enhances trans-C18:1 production. The objective of this study was to evaluate the effect of combining DHA with linoleic acid (C18:2) and linolenic acid (C18:3), using three different forages (oats, pasja, or alfalfa) on production of trans-C18:1 and conjugated linoleic acid (CLA) in batch culture. Treatments were as follows: 1) Forage, 2) Forage + 100mg C18:2, 3) Forage + 80mg C18:2 + 20mg DHA, 4) Forage + 100mg C18:3, and 5) Forage + 80mg C18:3 + 20mg DHA. Treatments (15 in total) were incubated in triplicate in 500 ml flasks containing 2g finely ground forage, 40 ml strained ruminal fluid, 160 ml media, and 8 ml reducing solution. A 5-ml sample of culture contents was taken at 24 h for fatty acid analysis by gas liquid chromatography. After 24 h of incubation, the concentration of trans-C18:1 was higher ($P < 0.01$) in cultures incubated with C18:2 than C18:3. Addition of DHA further increased the concentration of trans-C18:1 and the increase was greatest ($P < 0.01$) with T3. Forage type had no effect ($P > 0.05$) on trans-C18:1 concentration. Cis-9, trans-11 CLA was detected only in cultures incubated with C18:2 (T2 and T3) and concentration was higher ($P < 0.05$) with T3 than T2. The concentration of cis-9, trans-11 CLA was higher ($P < 0.05$) when pasja and alfalfa were used as forage source compared with oat. In conclusion, production of trans-C18:1 and cis-9, trans-11 CLA in rumen cultures were greatest

when DHA was incubated with linoleic acid. In addition, forage type used in this study had a minimal effect on trans fatty acids formation.

Key Words: Lipid source, Forage source, Trans fatty acids

266 The effect of solid dilution rate and lipid source on trans-C18:1 and conjugated linoleic acid production by ruminal microbes in continuous culture. W. R. Buckles¹, A. A. AbuGhazaleh^{*1}, G. A. Apgar¹, and K. E. Griswold², ¹*Southern Illinois University, Carbondale*, ²*The Pennsylvania State University, Lancaster*.

The objective of this study was to evaluate the effect of solid dilution rate (SDR) and lipid source (soybean oil (SBO), linseed oil (LSO)) on production of trans-C18:1 and conjugated linoleic acid (CLA). A dual-flow continuous culture system consisting of four fermenters was used in a 4 X 4 Latin square design with four periods of 10 d each (7 d for adaptation and 3 d for sampling). Treatment diets (50% alfalfa pellets, 50% concentrate) were fed (120 g/d DM basis) in three equal portions during the day. The concentrate mix contained 1% Fish oil (FO) and either 2% SBO or 2% LSO (DM basis). Treatments were as follows 1) SBO at 3%/hr SDR, 2) SBO at 6%/hr, 3) LSO at 3%/hr SDR and 4) LSO at 6%/hr SDR. The concentration of trans-C18:1 (36.5, 37.7, 32.0, and 36.2 mg/g of overflow for treatments 1-4, respectively) was higher ($P < 0.02$) with inclusion of SBO and was higher at 6%/hr SDR, when compared to 3%/hr SDR. Trans-11 18:1 concentration (32.5, 33.0, 28.2, and 31.1 mg/g of overflow for treatments 1-4, respectively) was higher ($P < 0.01$) with inclusion of SBO, but was not altered by changes in SDR. Concentration of cis-9, trans-11 CLA (0.94, 0.68, 0.41, and 0.39 mg/g of overflow for treatments 1-4, respectively) was higher ($P < 0.01$) with inclusion of SBO and at 3%/hr SDR compared with 6%/hr SDR. Addition of LSO significantly ($P < 0.01$) increased the concentration of trans-11, cis-15 C18:2 (1.60, 1.63, 9.45, and 9.22 mg/g of overflow for treatments 1-4, respectively). Biohydrogenation of C18:2n6 (0.88, 0.91, 0.89, and 0.91 for treatments 1-4, respectively) and C18:3n3 (0.88, 0.90, 0.93, and 0.95 for treatments 1-4, respectively) increased ($P < 0.01$) at higher SDR. Based on these results; SBO supplementation at high SDR may enhance ruminal production of trans-11 C18:1, and therefore, c9t11 CLA formation through delta-9 desaturase.

Key Words: Lipid source, Solid dilution rate, Trans fatty acids

267 Effect of aflatoxin on rumen microbial growth and efficiency in vitro. D. Srichana^{*}, G. E. Rottinghaus, P. Srichana, J. H. Porter, M. S. Kerley, and J. N. Spain, *University of Missouri, Columbia*.

Drought and heat stress of cereal grains increase the prevalence of mycotoxins in feeds fed to dairy cattle. The effect of aflatoxin (AF) on ruminal bacterial growth and fermentation was measured with batch culture and continuous culture experiments. In Experiment 1, feed containing AF at 0, 2 and 8 ppm were incubated with buffer and strained ruminal fluid at 39°C. Culture optical density (OD) was measured to estimate microbial populations. The cultures were sampled at 0, 6, 12, 24 and 36 h to measure fermentation products, pH and OD. The design was a completely randomized arrangement with 6 replicates per treatment. All differences discussed achieved a $P < 0.05$. Optical density,

ammonia, and total VFA increased overtime with no difference among treatments except at 6 h. At 6 h, OD was highest for feed containing 8 ppm AF (0.84), with feed containing no AF intermediate (0.78) and feed containing 2 ppm AF having the lowest OD (0.69). Ammonia concentration was different at 6 h (20.6, 16.8 and 18.5 mM for the 0, 2 and 8 ppm AF, respectively). In contrast, total VFA concentration at 6 h was different and was lowest for no AF (41.4mM) with 8 ppm AF intermediate (53.2mM) and 2 ppm AF having highest total VFA concentration (67.3 mM) at 6 h. Culture pH decreased overtime with no difference among treatments until 24 h. At 24 and 36 h, fermentors receiving feed containing 0 ppm (6.17 and 6.21) and 2 ppm (6.17 and 6.26) had lower pH than fermentors fed 8 ppm AF (6.26 and 6.37). In Exp 2, 15 fermentors (n = 5 fermentors per treatment) were fed diets containing AF at 0, 100 and 400 ppb for 3 days after a 3 day adaptation period. Fermentor temperature was maintained at 39°C in a water bath and artificial saliva was infused at a flow rate of 6 %/h. There was no effect of AF on the flow of bacteria N, OM digestibility or microbial efficiency. Ammonia, VFA and total VFA concentrations also were not different due to treatment. AF did alter bacteria composition (purine mg/g DM). Purine in bacteria DM was 150.8 for control fermentors, but increased with 100 ppb AF (166.0) and decreased with AF at 400 ppb (141.3). These data indicate that mixed culture rumen microorganisms were able to maintain normal growth and fermentation in the presence of increasing concentrations of AF.

Key Words: Aflatoxin, Microbial growth, Microbial efficiency

268 Effect of fumonisin on growth of ruminal bacteria in batch culture. D. Srichana*, G. E. Rottinghaus, P. Srichana, J. H. Porter, M. S. Kerley, D. R. Ledoux, and J. N. Spain, *University of Missouri, Columbia*.

Cereal grains produced under drought and severe heat stress are more susceptible to mold contamination. Fumonisin is a mycotoxin that has been isolated in feeds fed to dairy cattle. The effect of fumonisin (F) on ruminal bacterial growth and fermentation was measured in a batch culture experiment. Feeds containing 0, 100 and 200 ppm fumonisin were incubated with buffer and strained ruminal fluid at 39°C. Culture optical density (OD) was measured to estimate microbial populations. The cultures were sampled at 0, 6, 12, 24 and 36 h to measure fermentation products, pH and OD. The experimental treatments were arranged as a completely randomized design and analyzed using the Proc MIXED procedures of SAS. Differences were identified as $P < 0.05$. Optical density increased over time with no differences among treatments except at 12 h. At 12 h, OD was higher for cultures fed diets containing fumonisin at 100 (1.66) and 200 (1.62) ppm versus feed without F (1.41). Culture pH decreased over time and was significantly lower for feed without F than feed with F at 100 and 200 ppm over the entire period. The pH at 24h was 6.42b, 6.56a, and 6.58a for 0, 200 and 400 ppm F, respectively. Total concentration of VFA and concentration of acetic acid increased over time. Differences among treatments were

observed at 6 h. Feed containing 0 ppm F had higher total VFA and acetic acid concentrations compared to the other treatments at 100 and 200 ppm (75.6a, 68.2b and 69.3b mM total VFA; 46.0a, 40.7b, and 41.6b mM acetic acid, for 0, 100 and 200 ppm F, respectively). At 12, 24 and 36 h, feed containing 0 ppm F had lower propionic acid concentration than feed containing F at 100 and 200 ppm (12h: 18.9b, 19.0a, 19.0a; 24h: 19.1b, 19.2a, 19.2a; and 36h: 19.1b, 19.2a, 19.2a, for 0, 100 and 200 ppm F). Feed containing no F supported higher concentrations of ammonia and branch chain VFA (BCVFA) versus the other treatments from 6 h through 36 h. There was a high correlation between ammonia and BCVFA concentrations at sample times ($r = 0.97$). These results indicate that a change in ruminal microbial fermentation due to the presence of fumonisin in the feed supplied was measured in this in vitro fermentation system.

Key Words: Fumonisin, Ruminal bacteria, Batch culture

269 Stability of vitamin liposomes in rumen fluid. A. Cattaneo*¹, S. Loerch², F. Fluharty², and S. Peters³, ¹*College of Wooster, Wooster, OH*, ²*The Ohio State University, Wooster*, ³*Ingredient Innovations International, Wooster, OH*.

The objective of this project was to determine the stability of thiamine fortified liposomes during rumen fermentation (RF) in vitro and to quantify their ability to protect thiamine from microbial destruction. Liposomes are 100 nm diameter particles comprised of a phospholipid bilayer around an aqueous center. Duplicate 50 mL centrifuge tubes were incubated for each thiamine treatment (pure or liposome-protected), each source of inoculum (fresh or autoclaved), and each time of fermentation (0 or 24 h). Ground corn silage served as the substrate. After fermentation, samples were filtered and centrifuged twice to remove particles, microbes, and intact liposomes from the supernatant. Samples were analyzed using HPLC to determine the amount of non-encapsulated thiamine in the supernatant that would be potentially available for bacterial destruction. Regression analysis (PROG REG; SAS) was used to determine the release of thiamine to the supernatant over four doses (50, 100, 150 and 200 ppm). When liposome protected thiamine was added to RF at time 0, the slope of the regression of dose and thiamine concentration in the supernatant was 0.67, indicating 67 % of the thiamine was released into the supernatant prior to microbial action. Regression analysis was also used to determine the release of thiamine to the supernatant over 4 doses (50, 100, 150 and 200 ppm) following a 24 h fermentation. Slopes were calculated and compared to the slope of the titration of pure thiamine in autoclaved RF. Comparison of the slopes indicated 12% of the liposome protection was lost due to microbial action during the 24 h fermentation. When liposome protected thiamine was added to RF, the slope of the regression of dose and thiamine concentration in the supernatant was 0.79. Therefore, approximately 20% of thiamine in the liposome was protected during a 24 h in vitro fermentation.

Key Words: Rumen fermentation, Vitamin, Encapsulation

Teaching and Career Development

270 Environmental education targeting high school students and young adults. S. Boyles* and J. Rausch, *The Ohio State University, Columbus*.

There is a growing need for environmental education within agricultural education curriculum. Forty-eight percent of respondents in a survey of Ohio livestock producers identified manure management as the greatest environmental challenge facing their operations. Student Livestock Environmental Assurance Program (Student-LEAP) has been created through the cooperative efforts of the Ohio Livestock Coalition (OLC), Ohio Department of Natural Resources (ODNR), Ohio Federation of Soil & Water Conservation Districts (SWCDs), United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Ohio Environmental Protection Agency (Ohio EPA), and The Ohio State University Extension (OSUE). The primary goal is to produce a generation of highly qualified individuals who are prepared to work in fields that interface production agriculture with environmental issues related to, manure management, air and water quality. Best Management Practices (BMP) that minimize nutrient movement are highlighted. Modules on management address: odor, site evaluation, feedlot surface, egg wash water; milking center wastewater, silage storage, grazing strategies, nutrient storage and handling. The education modules include tools for teachers to assess changes in their students levels of knowledge and skills related to environmental stewardship. There are specific class exercises on environmental problem solution. The modules utilize more visual and hand-on experiences than the Adult-LEAP program. On-farm assessment tools are included for class projects. Each module has a list of questions for use by the instructor. This program links environmental assurance with agriculture, food production systems, and public health. Three training sessions with a total of nintey-eight vocational agriculture education instructors were conducted. Nintey-two percent of those attending these sessions have requested a copy of the curriculum. Our perceived need for environmental education within agricultural education curriculum appears to be merited based on the interest by vocational agriculture education instructors.

Key Words: Environment, Student, Education

271 Curricular two-stage learning process to develop persuasive argument and contemporary issue assessment skills in animal science students. B. Skaar*, P. Spike, and M. Kenealy, *Iowa State University, Ames*.

Graduates need to recognize the complexity of contemporary issues facing animal science and be able to communicate with others about these complex issues, often in settings requiring persuasive communication skills. In response, the animal science curriculum at Iowa State University requires a two-stage learning process of its students. First, sophomores are required to develop and exercise skills of recognizing and evaluating issues. Second, seniors are required to exercise their skills of persuasive argument by delivering oral and written presentations to persuade audiences toward action on issues of personal interest. During the first 6 weeks, sophomores develop abilities to evaluate ethical arguments, identify stakeholders and evaluate the use of references. Sophomores exercise their new skills by assessing guest presentations, textbook readings and items in the popular press. Simultaneously, senior students choose a topic about which they care deeply. This is a key

element in student motivation. Seniors research their topics and prepare arguments to persuade the audience to take action as per the direction of the speaker. Seniors cooperatively develop an assessment rubric, defining for themselves what constitutes effective. Seniors engage in cooperative learning activities to develop and test their arguments before preparing their presentations. After the first six weeks, the two courses are linked. Sophomores serve as an audience to learn from the senior students and to challenge their communication abilities. Sophomores prepare for each presentation by examining stakeholder viewpoints. Sophomores also apply the rubric in the evaluation of the presentations and, in small groups facilitated by seniors, provide commentary to serve as valuable feedback on each presentation. Finally, seniors are expected to prepare and submit for publication in contemporary press a feature-length editorial expressing their views on the issue and to call for public action. Rubric assessment scores averaging 7.1 on a 9.0 point scale indicate successful achievement of course outcomes in both courses.

Key Words: Curriculum, Communication skills, Issues

272 Scientific teaching centralizes diverse opinions on animal use. C. Jobsis* and M. Cook, *University of Wisconsin, Madison*.

Human/Animal Symbiosis: Law, Ethics and Practices is a class that seeks to inform the students about a variety of specifics surrounding the animal rights/animal welfare debate. The objective of the course is to teach the students to critically interpret information about the controversial subject of the use of animals for human benefit and more specifically to teach the students to use scientific data to support or refute a claim/opinion.

The purpose of this research project was to assess if the use of science in supporting an opinion would affect the student's outlook about animal rights/animal welfare issues. Will teaching students to critically evaluate a controversial subject utilizing scientific data impact their opinions regarding the subject? Given that the students chose to enroll in this course we hypothesized that they would be influenced by the literature and their opinions would tend to gravitate towards centrality. The students were surveyed on day one of the class and again at the end of the semester. The questionnaire asked them to respond to 9 opinion statements regarding animal rights and the use of animals in agriculture and research. They indicated their agreement or disagreement on a hedonic scale by placing a mark along a continuous line; agree to disagree. Responses were quantitated by measuring where they placed their mark along the line. The change in responses was measured by comparing day one data against data gathered at the end of the semester. Initial responses to statements reflecting attitudes towards animal rights were polarized. A trend toward centrality (neutral) was observed when students responded to the same questions at the end of the semester. When asked to respond to the statement "There is value in the animal rights movement today" 55% of the students agreed on day one, yet at the end of the semester 45% were neutral. By learning about the laws affecting animal use, considering varying ethical arguments about the subject and requiring the use of quantitative scientific data to support their statements of opinion students in this class appeared to have made a shift in attitude.

Key Words: Controversial subjects, Teaching, Animal rights

Dairy Extension Symposium - Innovations in Dairy Management

273 Effects of varying dry period length on lactation performance, efficiency of production and reproduction and energy status of dairy cattle. R. Rastani* and R. Grummer, *University of Wisconsin, Madison.*

Experiments were performed to examine the effects of varying dry period (DP) length on lactation performance, efficiency of production and reproduction and energy status in the subsequent lactation. The first study evaluated management schemes involving altered DP lengths. Compared with a 56 d DP, shortening the DP to 28 d and feeding a consistent high energy diet had no effect on postpartum solids-corrected milk (SCM) and dry matter intake (DMI). However, shortening the DP and feeding a consistent high energy diet improved EB, decreased the amount of body reserves mobilized, and decreased liver triglyceride accumulation postpartum compared with a 56 d DP. Eliminating the DP improved postpartum EB and metabolic status, due to increased DMI and decreased milk production. Time from parturition until first postpartum ovulation was earlier in cows with no DP compared with cows with a 28 d or 56 DP. The second study evaluated different DP lengths and prepartum milking frequency (MF) on subsequent milk production, milk composition, DMI and EB. Cows were milked 0x/d, 1x/d, and 4x/d for the last 28 d of gestation. All cows were milked 2x/d postpartum. There was a tendency for parity by treatment interaction for milk production. Postpartum milk production by cows following their third or greater gestation was greater for 0x/d and 4x/d compared with 1x/d. Postpartum milk production by cows following their second gestation was significantly decreased with increased MF (4x/d vs. 1x/d). Postpartum SCM was greater for cows milked 0x/d compared with cows milked 1x/d and 4x/d. However, there was no treatment effect on postpartum feed efficiency. Postpartum EB was greater for cows milked 1x/d and 4x/d relative to cows milked 0x/d. Continuous milking resulted in a loss of milk production for cows following the second gestation; however, increasing MF from 1x/d to 4x/d during the last 28 days of gestation eliminated the previously observed loss in milk production associated with continuous milking for cows following their third or greater gestation.

Key Words: dry period length, lactation, energy balance

274 Dry period nutrition and hepatic metabolism of fatty acids and glucose in transition dairy cows. N. Litherland*, *University of Illinois, Urbana.*

Improvements in transition cow management that enhance the health and welfare of dairy cows are critical to optimizing productivity. Dairy cows are challenged with astounding metabolic adaptations around parturition to support lactation. The liver is central to many of these processes, including gluconeogenesis and metabolism of fatty acids. Several aspects of dietary management may alter these adaptations, improve energy balance, and affect susceptibility to periparturient health disorders. Overfeeding during the far-off dry period may play a role in development of postpartum health disorders. In vitro measurement of palmitate oxidation and esterification in liver showed that excessive energy intake during the far-off period decreased liver oxidation and increased esterification of palmitate. Changes observed for in vitro liver metabolism were correlated with in vivo liver triglyceride accumulation postpartum. Measurements of gluconeogenesis are currently under-

way. Blood concentrations of NEFA rise at calving as cows mobilize fat stores to meet the sudden demands of lactation. NEFA are normally metabolized by mitochondrial oxidation, but after calving the rate of mobilization can exceed the capacity of the liver to oxidize them, leading to accumulation of NEFA in the blood and fat deposits in the liver. Lipid accumulation in the liver may contribute to other metabolic disorders and decrease milk production. Reduction of NEFA may offer an opportunity for improvement in the health and production of the transition cow. Enhanced oxidative capacity could decrease circulating NEFA and thus hepatic lipid accumulation. Agonists that activate the nuclear receptor for peroxisome proliferator-activated receptor A (PPARA) increase transcription and translation of enzymes responsible for β oxidation of NEFA in mitochondria and peroxisomes. The potential role of PPARA agonists are currently under investigation. New techniques such as functional genomics, proteomics, and metabolomics provide additional tools to determine the effects of nutrition and management on tissue function in development of disease.

Key Words: Transition period, Health, Liver metabolism

275 Growth parameters and blood profiles for Holstein and crossbred heifers according to phosphorous feeding level and breeding criteria. P. C. Hoffman, C. Simson*, C. Maltecca, K. A. Weigel, P. Pacitto, and T. Worch, *University of Wisconsin, Madison.*

Holstein (N=134) and crossbred 3/4 Holstein : 1/4 Jersey (N=63) heifers at the University of Wisconsin - Madison's Marshfield Agricultural Experiment Station were randomly assigned to two diets (with or without supplemental phosphorous) and two breeding criteria (by minimum age or by minimum weight). Data regarding body weight, hip height, body length, heart girth, and body condition score were collected monthly, while serum protein, glucose, cholesterol, and mineral levels were measured at 7, 14, and 21 months of age. Body length, body weight, heart girth, and hip height were significantly ($P < 0.001$) affected by breed of animal, while body weight and heart girth were also significantly ($P < 0.05$) affected by breeding criteria. Body measurements were unaffected by diet. With regard to blood profile measurements, stepwise model selection procedures yielded a statistical model containing the explanatory variables of month of birth, breed of heifer, and diet. Variation in body size and growth rate are important for dairy producers and custom heifer growers, because genetic differences in these traits might lead to suboptimal nutrition or reproductive management of certain groups of heifers.

Key Words: Heifers, Crossbreeding, Phosphorous

276 Compost barns as a lactating dairy cow housing system in the Midwest dairy industry. K. A. Janni*, M. I. Endres, J. K. Reneau, and W. W. Schoper, *University of Minnesota, St. Paul.*

Compost barns are an alternative loose housing system that provides excellent cow comfort for lactating cows. Producer experience with well-managed compost barns in the upper Midwest has been positive. Cows are relatively clean, very comfortable, have fewer lameness prob-

lems, and in some cases had lower somatic cell counts after moving to a compost barn. Current design and management recommendations are based on dairy producer experiences. Research is needed on these housing systems. Compost barns have a concrete feed alley, a bedded pack area that is stirred two times a day, and a 1.2-m high wall surrounding the pack. The wall that separates the pack and feed alley has walkways to allow cow and equipment access to the stirred pack area. Compost barns are recommended to have 1 m eave overhangs and 4.9 m sidewalls; this sidewall height enhances natural ventilation and provides height necessary for bedding trucks and stirring equipment access. Many compost barns have mixing fans that blow air downward toward the middle of the stirred pack to help dry the pack surface. The stirred pack is sized to provide a minimum stirred bedded pack area of 7.4 m² per cow. Producers use dry fine wood shavings or sawdust for bedding. It is hypothesized that the fine particles improve handling, mixing, aeration, and composting. Initially .3 to .5 m of dry fine wood shavings or saw dust is put down. Fresh bedding is added when the bedded pack becomes moist enough for it to stick to the cows after lying down on the stirred pack. The pack is stirred (aerated) at least two times each day. Experienced compost barn operators suggest that the pack be stirred to a depth of .25 to .30 m. Bedded pack stirring is usually done with a cultivator attached to the front of a skid loader. Stirring aerates and mixes manure and urine on the surface into the pack to provide a fresh surface for cows to lie down on. The aerated pack generates heat. Temperature data is needed. Research literature indicates that composting can inactivate pathogens and viruses. The pack can provide a year of manure storage.

Key Words: Dairy, Housing, Compost barn

277 Feeding fibrous residues to growing heifers. Alvaro D. Garcia*, *South Dakota State University, Brookings.*

Feed accounts for the single highest cost of raising dairy heifers. The goal of a heifer feeding program should be to provide enough nutrients to sustain adequate growth while minimizing rearing costs. A challenge of traditional feeding programs is to balance diet nutrient density and DMI to achieve optimum growth by a target age. Factors that influence DMI include body weight, dietary NDF, energy concentration, and DM content. It has been suggested NDF is a superior predictor of DMI as opposed to digestibility. Ration NDF content appears to have more influence than energy content on DMI and growth in heifers weighing less than 200 kg, whereas the opposite is true in animals that exceed that weight. Grain production in the Midwest results in an abundant supply of fibrous biomass with potential to be used as feed. Corn for ethanol production has also increased wet distillers grains (WDG) availability. Although WDG supplies nutrients in excess of those required by the growing dairy heifer (e.g. sulfur, phosphorus, fat, and RUP protein) it perfectly complements fibrous residues such as corn stalks and straw. Growth of young dairy heifers has been improved by diets that contain more total CP and RUP. Heifers receiving diets with more than 40% RUP consumed less DM and DE but gained more than heifers fed control diets (30% RUP). Increasing the RUP percentage in the diets of growing heifers thus improved feed efficiency and increased BW gain. Utilizing WDG in combination with low-cost, low-nutrient fibrous residues can result in decreased feed costs without sacrificing heifer growth. An experiment conducted at SDSU showed that dairy heifers (184 kg

BW) fed a WDG/corn stalks blend gained 1.05 kg/d, and had similar feed intake compared to controls. Although feed efficiency was greater for heifers fed the control diet, daily cost per head was \$0.343 less for the WDG/corn stalks fed heifers. The combination of WDG with fibrous residues results in blends that can meet or exceed heifer target growth rates. The use of fibrous residues can be an inexpensive alternative to more traditional feed sources in properly balanced dairy heifer rations.

Key Words: Heifers, Residues, Distillers grains

278 Limit feeding strategies to control energy intake and body condition of post-pubertal dairy heifers. P. C. Hoffman*, C. R. Simson, and M. Wattiaux, *University of Wisconsin, Madison.*

A study was conducted to evaluate the effect of limit-feeding on growth, feed efficiency and fecal excretion in gravid Holstein heifers. Gravid Holstein heifers (n=54) were randomly assigned to one of nine pens containing six heifers/pen. Heifers were fed one of three experimental diets for 111 d. Control heifers were ad libitum fed a diet containing 11.3 percent CP and 2.46 Mcals/kg of metabolizable energy (ME). Two experimental diets of increased nutrient density were formulated to contain 12.7 and 14.2 percent CP and 2.55 and 2.68 Mcals/kg of ME respectively. Feed intake of these diets was limited to 90 and 80 percent of control heifer feed intake. Nutrient intake, growth, fecal excretion, blood profiles, behavior and 90 d lactation performance of heifers were examined. Limit-fed heifers consumed less (P<0.01) DM (9.02, 8.30 vs 9.66 kg/d), similar amounts of net energy for gain (9.4, 9.5 vs. 9.4 Mcals/d) but slightly higher (P<0.07) amounts of CP (1.15, 1.17 vs. 1.10 kg/d) as compared to heifers fed ad libitum. Average daily gain or gain of body frame (height, hearth girth) was not different (P>0.10) between limit-fed and ad libitum fed heifers but feed efficiency was improved (P<0.09) by 1.04 kg DM intake/kg gain by limit-feeding. Limit-fed heifers excreted 0.36 and 0.86 kg less (P<0.10) DM but excreted similar amounts of N and P as compared to heifers fed ad libitum. Limit-fed heifers spent less (P<0.05) time eating, more (P<0.01) time standing without eating and vocalized more (P<0.03) than ad libitum fed heifers. Incidence of increased vocalization was minor and was negligible after 30d. Limit-feeding did not influence blood glucose, total protein, albumin, P or Ca as compared to ad libitum fed heifers but linear increases (P<0.07) in blood urea nitrogen were observed in limit-fed heifers due to higher N intakes. Parturition and lactation data were not available at the time of abstract submission. Limit-feeding of gravid heifers may offer opportunity to reduce feed cost, control body condition and reduce fecal excretion without negative effects.

Key Words: Heifers, Limit feeding, Growth

279 Systematic synchronization and resynchronization systems for managing reproduction in lactating dairy cows. P. Fricke*, R. Sterry, and E. Silva, *University of Wisconsin, Madison.*

Synergies between new reproductive management technologies hold the key to maximizing reproductive efficiency on dairy farms. Identifica-

tion of nonpregnant cows early post breeding can only improve reproductive efficiency when coupled with a management strategy to rapidly submit nonpregnant cows for a subsequent AI service. The various component technologies of the reproductive management system will in turn determine the timing of the events as they occur on a daily or weekly basis. It has long been accepted that pregnancy status should be determined in dairy cattle as soon as possible after insemination but without having the diagnosis confounded by subsequent embryonic mortality. Thus, one caveat of any method for early pregnancy diagnosis is that cows diagnosed pregnant early after AI are at risk for experiencing early embryonic loss and, therefore, must undergo subsequent pregnancy rechecks to identify and rebreed cows that experience embryonic loss. Furthermore, because the rate of pregnancy loss is great around the time an early nonpregnancy diagnosis is conducted, the

timing of first nonpregnancy diagnosis and pregnancy reconfirmation for those cows diagnosed pregnant becomes important. Over the past several years, our laboratory has investigated several systematic synchronization and resynchronization systems that detect nonpregnant cows and resynchronize them for subsequent timed AI. Development of integrated reproductive management systems that combine early identification of nonpregnancy with a strategy to rapidly return cows to AI service may further improve reproductive efficiency in lactating dairy cows. Our research on the practical implementation of early pregnancy diagnosis using transrectal ultrasonography into a systematic synchronization and resynchronization system has illustrated both benefits and limitations of early pregnancy diagnosis in systematic reproductive management systems.

Key Words: Dairy cow, Resynch, Pregnancy diagnosis

Nonruminant Nutrition - Distillers Dried Grains

280 Use of corn distiller's dried grains and solubles (DDGS) in late nursery pig diets. A. Gaines, B. Ratliff*, P. Srichana, and G. Allee, *University of Missouri, Columbia*.

Two experiments were conducted at a commercial research site in order to evaluate the use of corn distiller's dried grains with solubles (DDGS) in late nursery pig diets. In Exp. 1, a total of 345 pigs (TR-4×C22; 13.3±0.22 kg) were used in a completely randomized block design with 5 replicate pens/treatment (23 pigs/pen). Pigs were allotted to one of three dietary treatments: 0.0, 15.0, and 30.0% DDGS, respectively. Diets contained 2.5% choice white grease and were formulated at a lysine:calorie ratio of 3.66 g apparent ileal digestible lysine/Mcal ME. Growth performance was evaluated for 14 d. In Exp. 2, a total of 806 pigs (TR-4×C22; 11.5±0.14 kg) were used in a completely randomized block design with 6 replicate pens/treatment and 22 to 24 pigs/pen. Pigs were allotted to one of six dietary treatments in a 3 × 2 factorial design. The main effects included DDGS level (0.0, 15.0, and 30.0%) and fat level (0.0 and 5.0%) using choice white grease. Diets were formulated at a lysine:calorie ratio of 3.66 g apparent ileal digestible lysine/Mcal ME. Growth performance was evaluated for 21 d. In Exp. 1, there was no effect of DDGS level on ADG ($P=0.32$), ADFI ($P=0.10$), or Gain:Feed ($P=0.47$). In Exp. 2, there was no effect of DDGS ($P=0.40$) or fat level ($P=0.24$) on ADG. However, both DDGS ($P=0.03$) and fat level ($P=0.05$) improved Gain:Feed. Improvements in Gain:Feed were attributed to a lower ADFI in pigs fed DDGS ($P=0.02$) or supplemental fat ($P=0.05$). Collectively, these data indicate that up to 30% DDGS from today's modern ethanol plants can be used in 11 to 24 kg pigs without affecting late nursery pig performance.

Key Words: Distiller's dried grains with solubles, Growth, Nursery

281 Digestible and metabolizable energy in ten samples of corn distillers dried grains with solubles (DDGS) fed to growing pigs. C. Pedersen*, M. G. Boersma, and H. H. Stein, *South Dakota State University, Brookings*.

An experiment was conducted to measure digestible (DE) and metabolizable (ME) energy concentrations in ten samples of distillers dried grain with solubles (DDGS) fed to growing pigs. A corn-based basal diet was formulated. Ten diets consisting of 50% of the basal diet and 50% of each of ten sources of DDGS were also formulated. Each diet was fed to 11 growing pigs that were placed in metabolism cages and allotted to an 11 X 11 Latin square design. Total collections of urine and fecal materials were performed over a 5-d period. The total balance of energy, N, and P were calculated for each diet and the concentrations of DE and ME in each of the ten DDGS sources were calculated using the difference procedure. The apparent total tract digestibility (ATTD) of N and P were also calculated for each source of DDGS. Results of the experiment showed that the DE and ME for corn (4,090 and 3,989 kcal per kg DM, respectively) was not different from the average DE and ME in DDGS (4,191 and 3,871 kcal per kg DM, respectively). However, the values measured for DE in DDGS varied ($P = 0.001$) from 4,015 to 4,555 kcal per kg DM. Likewise, the values for ME in DDGS varied ($P = 0.001$) from 3,678 to 4,255 kcal per kg DM. The values for N-absorption from the ten sources of DDGS varied ($P = 0.006$) from 118 to 167 g over the 5-d collection period. However, pigs fed the corn-diet only absorbed 62 g of N which was less ($P = 0.001$) than the values for all the DDGS sources. The retention of N also was greater ($P = 0.001$) from DDGS (54.5 to 74.3 g) than from corn (25.5g), but there were no differences among sources of DDGS for N-retention. The average values for the ATTD of GE, N, and P in DDGS were 76.8, 83.0, and 59.1%, respectively. As with DE and ME, variations ($P = 0.01$) among the samples of DDGS were observed (73.9 to 82.8, 77.1 to 87.5, and 50.1 to 68.3%, respectively for the ATTD of GE, N, and P). It is concluded that the concentration of DE and ME in DDGS may vary among sources, but in general is close to the DE and ME in corn.

Key Words: Distillers dried grains with solubles, Energy digestibility, Pigs

282 The effect of steeping and enzyme supplementation of distillers dried grains with solubles on amino acid and energy digestibility in grower-finisher pigs. N. D. Fastinger^{*1}, C. Moran², and D. C. Mahan¹, ¹Ohio State University, Columbus, ²Alltech, Inc., Nicholasville, KY.

An experiment was conducted to evaluate the effect of steeping, enzyme or acid pretreatment of distillers dried grains with solubles (DDGS) on the apparent and standardized ileal amino acid and apparent ileal energy digestibility in grower-finisher pigs. The experiment was conducted as 2 X 2 factorial as a randomized complete block in three replicates. The factors evaluated were the addition of a 1 % crude enzyme cocktail (\pm Enz) and steeping DDGS in water for 24 h at 50°C (\pm Steep). Diets were formulated to 9% CP from the test DDGS (33% of the diet) and subsequently evaluated using the ileal digestibility technique in grower pigs. The experiment used six crossbred barrows averaging 30 kg BW, 62-d of age, and were surgically fitted with simple T-cannulas at the distal ileum. After a 10-d recovery period, treatment diets were initially fed in meal form to the animal's metabolic body weight. Pigs within a replicate were fed a constant quantity of feed for 7-d which included a 5-d adjustment period followed by 2 d collection of ileal digesta. A low-protein (5% casein) diet was used to determine basal endogenous amino acid losses and was fed to two animals per replicate. After the first two replicates, all pigs were fed a common corn-SBM based diet for 7-d prior to being re-randomized to the next replicate. Apparent and standardized ileal amino acid digestibility was calculated using chromic oxide (0.40%) as an indigestible marker. Apparent and standardized ileal amino acid digestibility of the essential amino acids were approximately 12% higher ($P < 0.05$) for the +Steep/+Enz treatment than the other three treatments. Apparent ileal energy digestibility was 16% higher in the +Steep/+Enz treatment than the other three treatments. These results suggest that steeping feedstuffs with an enzyme cocktail improved the nutritional amino acid and energy value of the DDGS more than simply adding the enzyme to the pigs diet and suggests that there is potential in this technology to be used for other feeds of low digestibility.

Key Words: Amino acid availability, Distillers dried grains with solubles, Pigs

283 Evaluation of reactive lysine (homoarginine) as an in-vitro procedure to predict lysine digestibility of distillers dried grains with solubles by growing pigs. A. A. Pahlm^{*}, C. Pedersen, and H. H. Stein, *South Dakota State University, Brookings.*

Two experiments were conducted to evaluate the reactive lysine (LysR) procedure to predict in-vivo Lys digestibility in distiller's dried grains with solubles (DDGS) by pigs. In this procedure, the conversion of lysine to homoarginine (Ha) is measured in a sample that has been incubated with methylisourea solution (MIU). In Exp. 1, the optimum guanidination in DDGS and in ileal digesta from pigs fed DDGS-containing diets was determined by varying the d of guanidination (1, 3, 6 and 9 d for DDGS and 1 and 3 d for ileal digesta) in 0.6 M MIU. For DDGS, there was a linear increase in Lys to Ha conversion (78.3, 81.0, 83.4, 82.9 %) for 1, 3, 6 and 9 d ($P < 0.01$). There was no difference in the average recovery of other AA among d of DDGS guanidination. For ileal digesta, there was no difference in the Ha conversion (72.7 and

74.9%) at 1 d and 3 d, respectively or for the recovery of other AA. It was concluded from Exp. 1 that samples of DDGS and ileal digesta need to be guanidinated for 3 d in a 0.6 M MIU solution. In Exp. 2, 13 DDGS samples from selected Midwest ethanol plants with previously determined standardized ileal digestibility (SID) of AA in growing pigs were guanidinated to determine the correlation of LysR content with the in-vivo Lys digestibility. The samples were guanidinated for 3 d at pH 11.4 using 0.6 M MIU solution. The results showed that the LysR content of samples ranged from 5.2 to 10.2 g kg⁻¹ (average 7.1 ± 1.3 g kg⁻¹). The Lys to HA conversion rate ranged from 72.6 to 85.4% (average $78.1 \pm 3.8\%$). The average total Lys content of the DDGS samples obtained using acid hydrolysis (LysAH) was 8.2 ± 0.8 g kg⁻¹, which means that the difference between LysAH and LysR is equivalent to 15%. This difference represents the unreactive Lys that may have been damaged because of Maillard reaction during the production of DDGS. The LysR content (g kg⁻¹) in the DDGS samples was highly correlated with SID Lys content (g kg⁻¹) ($R^2 = 0.87$) in DDGS. In conclusion, the reactive lysine procedure may be used as an in-vitro method to predict the SID Lys content of DDGS.

Key Words: Amino acids, DDGS, Reactive lysine

284 Excretion of P by sows fed dried distillers grains with solubles (DDGS) with or without phytase. G. M. Hill^{*1}, J. E. Link¹, D. L. Kirkpatrick¹, M. L. Gibson², and K. Karges², ¹Michigan State University, East Lansing, ²Dakota Gold Research Association, Sioux Falls, SD.

As the ethanol industry expands, DDGS is more available for use as a feedstuff in the livestock industry. The P in DDGS must be utilized to prevent excessive P excretion. The objective was to compare DDGS with a corn-soybean meal lactation diet and to examine the effect of phytase on P utilization. Eighty-nine sows were allotted to treatments based on parity and farrowing date. The treatments met or exceeded NRC (1998) and were: 1) control (**Con**), typical corn-soybean meal diet, 2) control + phytase - 500 FTU Natuphos/kg diet (**Con-P**), 3) Con with 17% of P supplied by 15% DDGS (**DG**), or 4) DDGS + phytase (**DG-P**). At approximately 110 d gestation sows were gradually introduced to their lactation diets. On d 2 of lactation litters were balanced to 11 pigs, and sows and litters were weighed. Fecal grab samples were collected from 12 sows/treatment on d 7, 14 and 18 of lactation. Feed was gradually increased to *ad libitum* intake until weaning at d 18. Litter weight gain (46.0, 46.3, 42.1, and 42.2 kg, $P = 0.253$) and sow weight loss (8.1, 7.2, 7.4 and 6.3 kg, $P = 0.972$) were not affected by treatment (**Con**, **Con-P**, **DG**, **DG-P**, respectively). Primiparous sows lost more weight than multiparous sows (10.9 vs. 3.7 kg, $P < 0.020$), and their litters were lighter at weaning (61.0 vs. 67.5 kg, $P < 0.012$). Fecal P concentration did not differ between treatment groups on d 7, 14 or 18, but was reduced in all treatment groups on d 14 and 18 compared with d 7. More importantly, fecal phytate P concentration was reduced ($P < 0.05$) in sows fed **DG-P** compared with sows fed all other treatments on d 14 and 18 (1.2 vs. 3.6, 2.6, 2.6; 1.1 vs. 3.7, 2.7, 2.2 mg/g; **DG-P** vs. **Con**, **Con-P**, and **DG**, respectively). Fecal Ca concentrations were reduced in sows fed the **DG** diets compared with **Con** diets on all collection days. Productive lactating sows can utilize DDGS P to meet their nutritional needs. Furthermore, dietary phytase may enhance P utilization from DDGS diets.

Key Words: Dried distillers grains, Sow lactation, Phosphorus

285 Effect of feeding diets containing corn distillers dried grains with solubles (DDGS), and formulating diets on total or available phosphorus basis, on phosphorus retention and excretion in nursery pigs. G. Xu^{*1}, M. H. Whitney², and G. C. Shurson¹, ¹University of Minnesota, St. Paul, ²Extension Regional Center, Mankato, MN.

Forty nursery pigs (10.37 ± 0.37 kg) were randomly allotted to one of five diets to determine the effects of dietary DDGS level (10 or 20%) and diet formulation method (available vs. total P basis) on P balance in nursery pigs. A corn-soybean meal control diet was (CS) formulated on a total P basis (TP), while four experimental diets containing 10 or 20% DDGS were formulated on a TP or available P basis (AP), using a relative P availability estimate of 90% for DDGS, and meeting the NRC (1998) P requirement. Pigs were fed experimental diets for a 7 d adaptation period followed by 5 d collection period. Digestibility of P (%) in pigs fed CS (61.4%) was similar ($P = 0.42$) to digestibility of P in pigs fed 10% DDGS (TP, 62.0%; AP, 61.4% respectively) and 20% DDGS (TP, 66.5%; AP, 62.8% respectively). Retention of P (g/d) in pigs fed CS, 10% DDGS diets, and 20% DDGS diets was also similar ($P = 0.29$), but within dietary DDGS level, pigs fed diets formulated on TP basis had higher ($P = 0.004$) P retention than pigs fed diets based on AP. Fecal excretion of P (g/d) was similar ($P = 0.50$) for pigs fed CS (1.0), 10% DDGS (TP, 1.05; AP, 0.96, respectively), and 20% DDGS (TP, 1.00; AP, 0.90, respectively). Similarly, urinary excretion of P (g/d) was similar ($P = 0.94$) in pigs fed CS (0.01), 10% DDGS diets (TP, 0.02; AP, 0.01 respectively), and 20% DDGS diets (TP, 0.02; AP, 0.01, respectively). Excretion of P in urine (g/d) was higher ($P = 0.04$) for pigs fed diets formulated on a TP basis compared to AP basis. No difference ($P = 0.35$) in the content of soluble P (0.0023 - 0.0043%) or insoluble P (0.081 - 0.110%) in manure was observed among dietary treatments. In conclusion, formulating diets containing 10 and 20% DDGS on a total or available P basis had no effect on digestibility, retention, or excretion of P which suggests that the relative P availability estimate of 90% for DDGS appears accurate.

Key Words: DDGS, Digestibility, Phosphorus

286 Effect of feeding diets containing corn distillers dried grains with solubles (DDGS), with or without phytase, on nutrient digestibility and excretion in nursery pigs. G. Xu¹, G. He², S. K. Baidoo², and G. C. Shurson^{*1}, ¹University of Minnesota, St. Paul, ²Southern Research and Outreach Center, Waseca, MN.

A nutrient balance trial was conducted to assess the effect of feeding diets containing 0 or 20% DDGS, with or without phytase (500 FTU/kg), on DM, N, and P balance in nursery pigs. Twelve pigs (8.79 ± 0.19 kg) were fed one of four experimental diets in a two period cross-over design (7 d adaptation period followed by a 5d collection period). Experimental diets consisted of: corn soybean meal (CS) without phytase (-PHY), CS with phytase (+PHY), DDGS without phytase (DDGS-PHY), and DDGS with phytase (DDGS+PHY). All diets except CS-PHY were formulated on an available P basis. Dry matter digestibility was higher ($P = 0.01$) for pigs fed CS-PHY (85.3%) and CS+PHY (84.7%) compared to pigs fed DDGS-PHY (80.9%) and DDGS+PHY (83.1%), resulting in lower ($P = 0.002$) fecal DM excretion (g/d) in pigs fed CS-PHY (73.3) and CS+PHY (73.4) compared to pigs fed DDGS-

PHY (89.6) and DDGS+PHY (84.3). Nitrogen digestibility was similar ($P = 0.41$) for pigs fed CS-PHY (85.1%), CS+PHY (82.6%), DDGS-PHY (79.5%), and DDGS+PHY (85.1%) diets, resulting in no difference ($P = 0.13$) in N excretion. Phosphorus digestibility was higher ($P = 0.03$) for pigs fed CS+PHY (60.4%) and DDGS+PHY (68.3%) compared to pigs fed CS-PHY (53.3%) and DDGS-PHY (56.5%). Pigs fed the CS+PHY diet had lower ($P = 0.05$) fecal P concentration compared to the CS-PHY diet, and feeding the DDGS+PHY diet further reduced fecal P concentration compared to feeding CS+PHY and DDGS-PHY diets. Fecal P excretion (g/d) was reduced ($P = 0.003$) in pigs fed CS+PHY (1.14) and DDGS+PHY (0.85) compared to CS-PHY (1.60) and DDGS-PHY (1.44). Although fecal P excretion was influenced by phytase ($P = 0.001$), no interaction ($P = 0.34$) between DDGS level and phytase was observed. Urinary P excretion (g/d) was similar ($P = 0.79$) among dietary treatments. These results suggest that the addition of phytase to CS and DDGS diets improves P digestibility and reduces P excretion in manure.

Key Words: DDGS, Phytase, Nutrient excretion

287 Effects of Ca:available P ratio on dry matter, nitrogen, phosphorus, calcium and zinc balance and excretion in nursery pigs fed corn-soybean meal based diets containing DDGS and phytase. G. Xu¹, G. He², M. Song¹, S. K. Baidoo², and G. C. Shurson^{*1}, ¹University of Minnesota, St. Paul, ²Southern Research and Outreach Center, Waseca, MN.

A nutrient balance trial was conducted to determine the optimal Ca:available P ratio in nursery pigs fed corn-soybean meal diets (CS) and CS diets containing 20% DDGS + phytase (500 FTU/kg). All diets were formulated on an available P basis to contain Ca:available P ratios of 2.0:1 (L), 2.5:1 (M), or 3.0:1 (H). Twenty four pigs (13.21 ± 0.56 kg) were fed one of six diets during a 7d adaptation period and a 5d collection period. Dry matter digestibility (%) of pigs fed CS diets (L, 88.1; M, 88.1; H, 88.7) was higher ($P = 0.05$) compared to pigs fed DDGS + phytase diets (L, 87.5; M, 87.1, H, 86.1). There was no difference in N digestibility (%) between dietary treatments. Phosphorus digestibility was higher ($P = 0.001$) when pigs were fed DDGS + phytase (L, 64.4; M, 60.0; H, 60.4) compared to pigs fed CS (L, 54.0; M, 53.6; H, 52.6). Therefore, pigs also had reduced ($P = 0.001$) P excretion (g/d) when fed DDGS + phytase (L, 1.10; M, 1.18; H, 1.19) compared to CS (L, 1.71; M, 1.71; H, 1.83). Digestibility of Ca (%) was higher ($P = 0.001$) in pigs fed CS diets (L, 65.7; M, 67.7; H, 72.0) compared to pigs fed DDGS + phytase diets (L, 52.9; M, 61.0; H, 61.6), and Ca digestibility was affected by Ca:available P ratio ($P = 0.02$). There was no difference in Zn digestibility (%) between pigs fed CS diets (L, 23.0; M, 20.2; H, 22.7) and DDGS + phytase diets (L, 21.6; M, 17.1; H, 19.1). Furthermore, there was no interaction ($P = 0.18$) between the addition of DDGS + phytase to the diet and Ca:available P ratio for DM, N, P, and Zn digestibility. These results suggest that the range (2.0:1 to 3.0:1) of recommended Ca:available P ratios recommended by NRC (1998) are acceptable when adding 20% DDGS and phytase to swine nursery diets to minimize P excretion in manure.

Key Words: DDGS, Digestibility, Swine

288 Effects of feeding diets containing corn distillers dried grains with solubles (DDGS), with or without phytase, on nutrient digestibility and excretion in grow-finish pigs. G. Xu^{*1}, M. H. Whitney², and G. C. Shurson¹, ¹University of Minnesota, St. Paul, ²Extension Regional Center, Mankato, MN.

A nutrient balance trial was conducted to examine the effects of adding phytase (500 FTU/kg) and 20% DDGS to corn-soybean meal based diets on DM, N, and P digestibility and excretion in grow-finish pigs. Twenty four grow-finish pigs (79.3 ± 1.63 kg) were utilized in 2 × 2 factorial arrangement of treatments. Four experimental diets consisted of corn-soybean meal (CS) without phytase (-PHY), CS with phytase (+PHY), CS+DDGS-PHY, and CS+DDGS+PHY. Pigs were fed their respective experimental diets for a 10d adaptation period followed by a 5d total collection period. There was no difference ($P = 0.17$) in DM digestibility of pigs fed CS-PHY (88.5%), CS+PHY (88.9%), DDGS-PHY (87.3%), and DDGS+PHY (86.7%), resulting in similar ($P = 0.16$) DM excretion (g/d) in pigs fed CS-PHY (240), CS+PHY (234), DDGS-

PHY (269) or DDGS+PHY (278). Nitrogen digestibility in pigs fed CS-PHY (85.2%), CS+PHY (87.6%), DDGS-PHY (85.4%), and DDGS+PHY (85.8%) was not affected ($P = 0.40$), but there was a trend ($P = 0.09$) for reduced fecal N excretion (g/d) in pigs fed diets containing phytase. Urinary N excretion (%) was similar ($P = 0.16$) in pigs fed CS-PHY (0.89), CS+PHY (0.48), DDGS-PHY (0.61) and DDGS+PHY (0.36), but there was an interaction between DDGS level and phytase ($P = 0.03$). Pigs fed CS+PHY (55.0%) had higher ($P = 0.02$) P digestibility than pigs fed CS-PHY (46.6%). Similarly, feeding DDGS+PHY (46.6%) led to improved ($P = 0.02$) P digestibility compared to feeding DDGS-PHY (42.3%). The addition of phytase to the diet reduced ($P = 0.008$) fecal P excretion (CS-PHY, 5.15 g/d; CS+PHY, 3.76 g/d; DDGS-PHY, 5.40 g/d; DDGS+PHY, 4.05 g/d). There were no interactions ($P = 0.1$) between DDGS and phytase level for DM, N and P digestibility. In conclusion, digestibility of P was improved and excretion of P was reduced in pigs fed corn-soybean meal and DDGS diets containing phytase.

Key Words: DDGS,, Phytase, Nutrient excretion

Nonruminant Nutrition - Nutrition of Weanling Pigs

289 Assessment of lactose levels in Phase 3 nursery diets for young pigs. G. L. Cromwell^{*1}, G. L. Allee², and D. C. Mahan³, ¹University of Kentucky, Lexington, ²University of Missouri, Columbia, ³The Ohio State University, Columbus.

An experiment involving 1,320 crossbred pigs was conducted at three universities to assess the effects of level of lactose in starter diets during Phase 3 of a four-phase starter program. Pigs were weaned at 15 to 20 d (6.2 kg initial weight) and allotted to five treatments. All pigs were fed a complex Phase 1 diet (20% lactose) for 7 d followed by a complex Phase 2 diet (15% lactose) for 7 d. Phase 3 diets containing 0, 2.5, 5.0, 7.5, or 10.0% lactose were fed for 14 d. Pigs were then fed a common corn-soybean meal diet for an additional 7 to 14 d (Phase 4). The source of lactose was DairyLac[®]80, (International Ingredient Corp., St. Louis, MO), which contains 80% lactose. The Phase 1, 2, and 3 diets were prepared at one site (MO). Pigs were weighed and feed intake was determined at weekly intervals. There were eight pen-replications at each station for a total of 24 replications/treatment with 5 (KY, OH) or 23 (MO) pigs/pen. As expected, pig performance was not affected ($P = 0.10$) during the initial 14-d period (ADG = 288, 288, 281, 285, 290 g/d; ADFI = 350, 342, 343, 357, 350 g/d). During the 14-d period of Phase 3 (when the five levels of lactose were fed), ADG and ADFI increased linearly ($P < 0.01$) with increasing levels of lactose, but feed:gain was not affected ($P = 0.10$). Although the quadratic component was not significant, ADG and ADFI appeared to reach a plateau at the 7.5% level of lactose inclusion during Phase 3 (532, 533, 547, 557, 558 g/d; 723, 724, 735, 753, 752 g/d) and during Phases 1, 2, and 3 combined (410, 411, 415, 421, 424 g/d; 537, 533, 538, 555, 551 g/d). Over the entire 5 to 6-wk study, ADG was 490, 490, 492, 497, 494 g/d, ADFI was 676, 679, 672, 689, 690 g/d, and feed:gain was 1.38, 1.37, 1.37, 1.38, 1.40, for the five groups, respectively. Compared with controls, the 7.5% level of lactose resulted in 350 g of additional weight gain per pig during Phase 3 (associated with 413 g of additional feed consumed per pig), and most of the additional weight gain (295 g per pig) was maintained through the end of the study.

Key Words: Pigs, Lactose

290 Value of degermed-debranned corn in nursery pig diets. J. Beagle, M. Walsh*, D. Sholly, K. Saddoris, R. Hinson, A. Bogart, D. Kelly, B. Richert, J. Radcliffe, and A. Sutton, Purdue University, West Lafayette, IN.

Weanling pigs (n=180; 19 d of age; 5.9 kg BW) were used in a 5-week growth trial (Exp. 1) to assess degermed-debranned corn (DDC) in nursery pig diets. Pigs were blocked according to weight, sex, and ancestry. Treatments were: 100% conventional corn (CONV); 33% DDC: 67% CONV (33:67); 67% DDC: 33% CONV (67:33); 100% DDC (DDC); 100% DDC with increased Lys and amino acids (AA) to an equal Lys:calorie ratio as Diet 1 (DDC+AA). All diets were formulated to be similar in available phosphorous (P) and AA content and were fed in 3 phases; Phase 1 (d 0-14), Phase 2 (d 14-28) and Phase 3 (d 28-35). Pigs were housed in 30 pens with 6 pigs/pen and 6 pens/diet. Pig BW and pen feed intake were recorded weekly and ADG, ADFI, and gain to feed (G:F) were calculated weekly, by diet phase, and overall. A metabolism trial (Exp 2) was conducted to evaluate P, nitrogen (N), dry matter (DM), and energy digestibility and excretion from nursery pigs fed DDC diets. Two replicates of 12 barrows each were blocked by weight and ancestry and continued on treatments through two dietary phases (Phase 2 and 3). Four diets were fed: CONV; DDC; and with or without 500 phytase units (PU)/kg. Each phase was a 10-d metabolism period which included a 7-d adjustment period to the diets and a 3-d urine and feces total collection. Pig ADG and ADFI were similar ($P > 0.05$) for DDC diets compared to CONV at all time periods. Overall feed efficiency was improved ($P < 0.001$) 7% by the DDC diet compared to the CONV diet (0.842 vs 0.787) and G:F increased linearly ($P < 0.0001$) as DDC increased in the diet. Over both phases, the DDC diets increased ($P < 0.001$) DM, energy, and P digestibility and reduced ($P < 0.001$) DM (34%), energy (36%) and P (34%) excretions. The inclusion of phytase in the diets increased ($P < 0.01$) P digestibility and reduced ($P < 0.01$) P excretion (32%). Water soluble P excretion was reduced 43% with DDC diets compared to CONV diets ($P < 0.001$). The removal of the fiber and bran fraction of the corn kernel improved feed efficiency and energy and P digestibility in the nursery pig and can substitute for conventional corn in nursery pig diets.

Key Words: Dry milled corn, Growth performance, Nutrient excretion

291 Effect of dietary flaxseed, flax hulls or linseed oil on intestinal microbiota and growth performance in weaned pigs. A. G. Van Kessel*¹, M. D. Drew¹, J. F. Patience², and R. T. Zijlstra³, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Prairie Swine Centre, Inc., Saskatoon, SK, Canada, ³University of Alberta, Edmonton, AB, Canada.

The physico-chemical properties of flaxseed (linseed) suggest possible beneficial effects on intestinal microbial colonization and post-weaning performance in the young pig. Therefore, 256 weaned pigs (5.80 ± 0.07 kg), balanced for initial BW were weaned at 21 days of age and assigned to one of 32 pens in 2 replicate experiments. Pigs were fed one of eight experimental diets formulated to provide similar nutrient content (3.55 Mcal/kg DE and 3.8 g digestible lysine/Mcal DE). The diets included a wheat and soybean meal-based control diet (CTL), control diet plus LS20 (22 mg/kg each of lincomycin and spectinomycin; antibiotic), control diet plus 5% (FS5) or 10% ground flax seed (FS10), control diet plus 1% (FH1) or 2% flax hulls (FH2), and control diet plus 2% (LO2) or 4% linseed oil (LO4). Pen weight and feed intake were recorded on days 4, 7, 14 and 21 post-weaning. Feces were collected at the same intervals for enumeration of lactobacilli and coliforms. One pig per pen was killed on day 5 post-weaning for enumeration of lactobacilli and coliforms in the distal ileum. Overall, ADG, ADFI, and G:F were not affected by diet. In both replicate studies, ADG from d 0 to 4 was higher ($P < 0.05$) in pigs fed the FH2 diet versus all other diets, but this effect was not apparent in subsequent periods. Similarly, G:F was higher ($P < 0.05$) for the d 0 to 4 period only in pigs fed FH2 and LO4 diets compared with CTL or LS20 diets. No significant effects of antibiotic, flax hulls or oil on fecal or ileal microbial counts were observed, in contrast to previous studies in our laboratory. In conclusion, whole flaxseed, flax hulls or linseed oil can be included in post-weaning diets without a negative effect on pig growth performance. However, since a performance benefit of antibiotic was not detected, health implications of flax supplementation on pig growth performance could not be assessed in this study.

Key Words: Flax, Pig, Intestinal microbiology

292 Effects of feeding increased concentrations of vitamin B₁₂ on growth performance in weanling pigs. L. Albrecht*, R. Fischer, and P. Miller, University of Nebraska, Lincoln.

This study was conducted to investigate the effects of feeding graded concentrations of vitamin B₁₂ to weanling pigs. One hundred forty-four weanling pigs (4.6 kg BW) were assigned to one of six dietary treatments: NC, negative control, a typical nursery diet without supplemented vitamin B₁₂; or the basal diet with the inclusion of 100% (1X, 17.5 Mg/kg), 200% (2X, 35 Mg/kg), 400% (4X, 70 Mg/kg), 800% (8X, 140 Mg/kg), or 1600% (16X, 280 Mg/kg) of NRC vitamin B₁₂ requirements for the 5- to 10-kg pig. Pigs were weaned at 13- to 14-d and allotted to treatment based on weaning weight, sex, and litter. Two barrows and two gilts were housed per pen with six pens/treatment. Pigs and feeders were weighed weekly for the 35-d study (phase 1, d 0 to 14; phase 2, d 14 to 35). Data were analyzed as a completely randomized block design using the MIXED procedure of SAS with treatment as the main effect and pen as the experimental unit. There were no differences in ADG, ADFI, or ADG/ADFI among treatments during phase 1. For phase 2, there was a linear increase in ADG (489, 536, 552, 535, 557, and 563 g, respectively; $P < 0.05$) and ADFI (720, 749, 779, 768,

789, and 792 g; $P < 0.05$) with increasing concentrations of B₁₂. During phase 2, only the 1X treatment had greater ($P < 0.05$) ADG/ADFI (716 g/kg) than the NC (ADG/ADFI = 679 g/kg). For the entire study, there was a linear increase in ADG (377, 412, 422, 407, 436, and 436 g; $P < 0.01$) and ADFI (554, 579, 596, 591, 613, and 614 g; $P < 0.05$). The 1X, 8X, and 16X treatments had greater ($P < 0.05$) ADG/ADFI (712, 711, and 710 g/kg) than the NC (681 g/kg) for the overall experimental period. These results suggest that feeding concentrations of vitamin B₁₂ greater than the NRC recommendation may increase ADG and ADFI of weanling pigs.

Key Words: Pigs, Vitamin B₁₂, Growth

293 Addition of arginine-HCl did not improve performance in 7-d old milk-fed pigs. R. Cabrera*¹, J. Perez¹, J. Usry¹, R. Harrell¹, J. Vignes¹, M. Johnston¹, and R. Boyd¹, ¹Ralco Nutrition, Marshall, MN, ²Reproductores Porcinos, La Antigua, Guatemala, ³Ajinomoto Heartland, Chicago, IL, ⁴North Carolina State University, Raleigh, NC, ⁵Birthingright Animal Nutrition, Delano, MN, ⁶The Hanor Company, Spring Green, WI.

Arginine (ARG) is an indispensable amino acid for the neonatal piglet and sow's milk contains low levels of ARG relative to the estimated requirement. Enterocytes of small intestine are almost the exclusive cells for the synthesis of citrulline and arginine from glutamine/glutamate and proline in piglets. This synthesis decreases by 60-75% in 7-d old pigs when compared to newborn piglets and declines further in 14-d and 21-d old suckling piglets. The effect of adding ARG-HCl was tested in a total of 400 7-d old milk-fed pigs (200 pigs/treatment) using a milk replacer (Control, 0.8% total ARG) and adding 3.6 kg/ton of synthetic ARG (1.2% total ARG). The milk replacer was formulated to contain 24% crude protein, 18% fat and 2.2% total lysine. The milk replacer was mixed fresh daily at a rate of 0.14 kg of powder per liter of water and was fed using a semi-automated milk system where the milk was available 24 h per d. Pigs were weaned at 7 d of age and weighed 3.1 kg (SE = 0.11). They were housed in rooms with temperature at 90 degrees Fahrenheit and in pens measuring 1.52 x 0.91 m. Data were analyzed using a model with treatment, size, and treatment x size interaction as variables. Size x initial BW were used as covariates in the analysis of weaning BW and ADG. Body weight of Control pigs at weaning was greater ($P=0.05$) than that of ARG pigs (6.6 vs 6.4 kg, respectively). Daily gain was also greater ($P=0.05$) for Control vs ARG pigs (0.29 and 0.27 kg, respectively). Mortality (2% vs 0%) and "fall back" (4.5% vs 2%) rates were greater in the ARG group than in the Control group, respectively. The addition of ARG-HCl did not improve performance in 7-d old milk-fed pigs.

Key Words: Arginine-HCl, Milk replacer, Neonatal swine

294 The effect of feeding organic and inorganic sources of zinc on growth performance and microbial population in nursery pigs. L. M. Pulz* and M. S. Carlson, University of Missouri, Columbia.

The experiment was conducted to evaluate the effect of feeding pharmacological concentrations of zinc (Zn), from organic and inorganic sources, on growth performance and intestinal microbial population in nursery

pigs. Ninety-six crossbred pigs (6.74 ± 0.25 kg; 19 ± 1 day of age) were weaned and allotted to 1 of 4 treatments based on weight and ancestry (3 pigs/pen and 8 reps), for the duration of the 28-d study. Phase 1 (d 1 to d 14) and Phase 2 (d 15 to d 28) nursery diets were fed in meal form. Both dietary phases utilized 4 dietary treatments: (1) Basal diet contained 165 ppm Zn as $ZnSO_4$ which was supplied by the trace mineral premix, (2) Basal + 3,000 ppm Zn as inorganic ZnO, (3) Basal + 250 ppm Zn as organic Zn proteinate, and (4) Basal + 250 ppm Zn as organic Zn polysaccharide. Body weights, feed disappearance, and fecal swabs were collected weekly. Fecal swabs were collected to obtain the metabolic capacities and biochemical phenotypes of the pigs' colonic microflora over time and treatments. Nursery pigs fed diets containing 3,000 ppm Zn as ZnO had greater average daily gain in wk 2, wk 3, Phase 1, and overall ($P = 0.05$). During wk 2, wk 3, Phase 1, Phase 2 and overall, pigs fed with 3,000 ppm Zn as ZnO had greater feed intake than pigs fed the control or organic Zn diets ($P = 0.05$). In wk 3, feed efficiency (gain/feed) improved when pigs were supplemented with ZnO ($P = 0.05$). These results indicate that feeding 250 ppm Zn as organic Zn has no impact on growth performance. However, supplementing 3,000 ppm Zn as ZnO in the nursery pigs diets improved growth performance throughout the 28 day study. Data showed that nursery pigs supplemented with inorganic or organic Zn sources exhibited higher correlation values between the biochemical phenotypes of colonic microflora than pigs supplemented with control diet. Therefore, these data support that the possible mode of action behind improved growth performance observed in nursery pigs fed high Zn is due to enteric changes in microbial populations.

Key Words: Weaned pigs, Zinc, Growth performance

295 Additivity of effects of copper from copper sulfate or Availa®Cu and zinc oxide in diets for weaned piglets. V. G. Perez-Mendoza*¹, G. R. Hollis¹, T. M. Fakler², and J. E. Pettigrew¹, ¹*University of Illinois, Urbana*, ²*Zinpro Corporation, Eden Prairie, MN*.

An experiment was conducted at the University of Illinois Swine Research Center to test whether the performance effects of high levels of zinc oxide were additive with the effects of high levels of either copper sulfate or Availa-Cu. Newly weaned pigs (21-d old) were blocked by weight and randomly assigned to pens with four pigs (two barrows and two gilts) per pen and five pens per treatment for a total of 120 pigs. The experiment lasted 6 wk, using a 4-phase feeding program with declining diet complexity. There were six treatments in a 3x2 factorial arrangement of treatments. The factors were Cu (none; 250 ppm Cu from $CuSO_4$; 100 ppm Cu from Availa-Cu) fed throughout the entire experiment, and ZnO (0 vs 3000 ppm Zn) fed only during the first 2 wk. These high levels of Cu and Zn were in addition to the nutrient levels provided by the standard trace mineral premix. The statistical analyses by the MIXED model of SAS used five preplanned orthogonal contrasts to assess the main effects of Cu and of ZnO, the difference between Cu sources, the interaction between Cu and ZnO, and the interaction between copper source and ZnO. There were no Cu by ZnO interactions ($P > 0.05$). Zinc oxide decreased ADFI (193 vs 159 g; $P < 0.03$), and ADG (134 vs 99 g; $P < 0.07$) during Wk 1, but in Wk 2, ZnO improved ADFI (417 vs 494 g; $P < 0.001$) and ADG (308 vs 431 g; $P < 0.001$). Cu supplementation increased ($P < 0.01$) overall ADFI (680 vs 731 g) and ADG (445 vs 484 g). In Wk 2, Availa-Cu improved ADG over $CuSO_4$ by 58 g (349 vs 407 g; $P < 0.02$). This difference tended to be greater in the presence of ZnO (85 g) compared to the absence of

ZnO (31 g), but the Cu source by ZnO interaction was not significant. In addition, from weaning thru Wk 4, feeding Availa-Cu improved ADG over $CuSO_4$ by 28 g (376 vs 404 g; $P < 0.07$). In summary, these results show beneficial effects of high levels of both ZnO and Cu in diets for weaned piglets, and the lack of Cu by ZnO interactions suggests that these effects are at least partially additive. Availa-Cu appeared superior to $CuSO_4$.

Key Words: Weaning pigs, Copper supplementation, Zinc oxide

296 Meta-analysis of the influence of gender, weaning weight, and weaning age on post-weaning performance in pigs. L. J. M. Jönsson*, D. N. Peters, C. Pedersen, and H. H. Stein, *South Dakota State University, Brookings*.

Performance data from 13 experiments with weaned pigs were included in a meta-analysis to determine the influence of gender, weaning weight, and weaning age on post-weaning pig performance. Data for ADG, ADFI, and G:F were used in the analysis that included a total of 1,358 pigs (average age at weaning: 19.2 ± 2 d). In all experiments, weight and sex were registered at the d of weaning. The ADG, ADFI, and G:F were calculated for the initial 7 d post-weaning, for the initial 14 d post-weaning, and at d 35 post-weaning. Results of the analysis showed that increased weaning weight increased ($P = 0.01$) post weaning ADG. If weaning weight was increased by 1.00 kg, then pig weight would be increased ($P = 0.01$) by 1.020, 1.090, and 1.420 kg at d 7, 14, and 35, respectively. At weaning, barrows were heavier ($P = 0.02$) than gilts (5.78 vs. 5.64 kg), but gilts were heavier than barrows at d 7 (6.13 vs. 6.03 kg; $P = 0.01$) and at d 14 (8.08 vs. 7.96 kg; $P = 0.01$). At d 35, there was a tendency ($P = 0.06$) for gilts to be heavier than barrows (18.14 vs. 17.75 kg). The ADG was increased ($P = 0.001$) with increased weaning age. For each one d increase in age at weaning, pig BW was increased by 0.145, 0.230, 0.280, and 0.390 kg at d 0, d 7, d 14, and d 35 post-weaning, respectively. There was no effect of weaning weight on G:F during the initial 7 d post-weaning, but during the initial 14 d post-weaning, G:F was negatively influenced by increased weaning weight (linear effect, $P = 0.02$). During the entire 35-d period, a quadratic effect ($P = 0.001$) of weaning weight on G:F was observed. The lowest G:F was observed for pigs weaned at 6.5 kg. The weight at weaning was only moderately correlated with age at weaning ($R^2 = 0.34$) which indicates that factors other than age contributes to the weight at weaning. The results of the present meta-analysis indicate that gilts have higher ADG during the post weaning period than barrows and that post-weaning ADG is improved by increased weaning weight. The poorest post-weaning G:F is obtained if pigs are weaned at a weight of 6.5 kg.

Key Words: Performance, Pigs, Weaning weight

297 Inclusion of zero-tannin fababeans and substitution for soybean meal in nursery diets on weaned pig performance. F. Omogbenigun¹, R. Zijlstra², and E. Beltranena*¹, ¹*Alberta Agriculture, Food and Rural Development, Edmonton, AB. T6H 5T6, Canada*,

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Three hundred crossbred Hypor piglets were used in a 21 d trial to determine the effect of the dietary inclusion of 0, 10, 20, 30 and 40% locally-grown zero-tannin fababean in substitution for imported soybean meal on post-weaning growth performance. At weaning and on Day -3 (d 11 post-weaning), available pigs were weighed, and the derived BW gain was used to select suitable pigs for the trial. Selected pigs were then sorted based on gender and litter of origin. Gilts and barrows were then sorted into weight categories. Pigs within gender and weight category were randomly allocated to pens so that each pen had 2 gilts and 2 barrows. The five test diets were then randomly assigned to pens, and pigs had ad libitum access to the diets for three weeks. Pigs were then individually weighed on day 0, 7, 14, and 21. Fresh fecal grab samples were collected randomly from one pig in each pen for the last three days of the study, were pooled and analyzed to calculate digestibility coefficients. For each weekly period and the overall trial, ADFI, ADG, and G:F were similar ($P > 0.05$) among treatments. In summary, these results indicate that locally grown zero-tannins fababean can totally substitute imported soybean meal in late nursery diets and that weaned pigs do not require a progressive dietary adaptation to Snowbird fababean.

Table 1. Dietary inclusion of zero-tannin fababean

35 - 56 d of age	0%	10%	20%	30%	40%	SEM
ADFI, g	876	868	857	840	845	19.2
ADG, g	578	580	570	572	570	14.6
G:F	0.67	0.68	0.68	0.69	0.68	0.01

Key Words: Pigs, Fababean, Growth performance

298 Influence of irradiation of spray dried animal plasma added to meal or pelleted diets on growth performance of weanling pigs.

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A total of 192 weanling pigs (5.99 kg BW, 21 ± 3 d of age) were used in a 25-d growth assay to determine the effects of feeding meal and pelleted

diets with irradiated or non-irradiated spray-dried animal plasma (AP 920) on growth performance. Pigs were blocked by weight, and randomly allotted in a 2 × 2 factorial to one of four dietary treatments. Main effects were diet form (meal or pellet) and either irradiated or non-irradiated spray-dried animal plasma. Experimental diets were fed from d 0 to 11 with all pigs fed a common diet from d 11 to 25. Irradiation of the spray dried animal plasma reduced the total bacterial plate count from 1.1×10^5 to less than 1.0×10^1 CFU/g. Pelleting the non-irradiated plasma diet reduced the total bacterial plate count from 2.6×10^4 to 2.0×10^3 CFU/g. From d 0 to 3, irradiation of spray-dried animal plasma had no effect on performance; however, pigs fed pelleted diets had greater ($P < 0.03$) ADG, ADFI, and G:F compared with pigs fed meal diets. There was a diet form × plasma irradiation interaction ($P < 0.01$) for ADG and G:F from d 3 to 11 and for ADG and G:F ($P < 0.07$) from d 0 to 11. From d 11 to 25, all pigs were fed common diet, in meal form, pigs previously fed the non-irradiated spray dried animal plasma meal diet had reduced growth performance through d 25 compared to those fed the irradiated spray dried animal plasma meal and pelleted diets. Therefore, plasma irradiation and pelleting improved pig growth rate and feed efficiency but not in an additive manner. Pigs fed diets containing irradiated spray-dried animal plasma in meal form had similar growth performance to pigs fed pelleted diets. For producers that manufacture meal diets containing plasma, irradiation of the plasma can improve pig performance.

Table 1.

	Non-irradiated Plasma Meal	Non-irradiated Plasma Pellet	Irradiated Plasma Meal	Irradiated Plasma Pellet	SE
D 0 to 3					
ADG, g	225	297	218	306	23.6
ADFI, g	130	169	137	166	13.2
Gain/feed	1.74	1.78	1.59	1.83	0.07
D 3 to 11					
ADG, g	305	384	396	400	17.7
ADFI, g	427	451	468	449	19.0
Gain/feed	0.72	0.84	0.85	.90	0.02
D 0 to 11					
ADG, g	283	360	348	374	16.5
ADFI, g	346	373	378	371	16.5
Gain/feed	0.82	0.96	0.92	1.01	0.01

Key Words: Pig, Irradiation, Plasma

Physiology - Topics in Physiology

299 Investigation of molecular mechanisms of bovine ovarian follicular selection.

Z. Liu*, R. Youngquist, A. Garverick, and E. Antoniou, *University of Missouri, Columbia.*

It is reported that about half of human infertility is due solely to the female, and caused by reasons such as ovulation dysfunction. Diagnosis and treatment of this infertility are not easy due to our limited understanding of basic molecular and cellular mechanisms driving folliculogenesis. Cattle provide good models for understanding the folli-

cular development process, as cattle like humans, are monovular and stages of follicular development can easily be followed by real-time ultrasonography. The objectives of this study are to identify changes in gene expression profiles during the selection stage of bovine follicular waves. Follicles of different sizes were collected and intrafollicular concentrations of progesterone, estradiol and androstenedione were measured to provide additional information on the status of the follicles. Gene expression profiles were obtained using cDNA slides containing ~18K bovine EST probes. A group of clones (219) were found to be

significantly up-regulated in the size 8.5mm follicles (FDR<15%), a stage where selection occurs. Among them, 199 probes represent 65 unique annotated genes while 20 probes do not have functional annotation. Annotation of the human orthologs of the 65 genes showed these genes are involved in a variety of biological processes, including immune response, signal transduction and cell communication. A detailed investigation of these differentially expressed genes would help us to elucidate the follicular selection process.

Key Words: Ovarian follicle selection, Microarray

300 Comparison of fertility, luteal characteristics, and luteal function between unilateral and bilateral double ovulations. R. Cushman*, M. Allan, R. Christenson, and S. Echterkamp, *USDA, ARS, Meat Animal Research Center, Clay Center, NE.*

Bilateral ovulation may be a heritable trait that could improve prolificacy and fertility in ruminants, because bilateral double ovulations were reported to increase early embryonic survival compared to unilateral double ovulations. The current study tested the hypothesis that early embryonic survival is increased in bilateral ovulations due to enhanced luteal function. Cows selected for multiple ovulations (n = 91) were examined by ultrasound at insemination to determine the number and diameter of all follicles = 8 mm, at the mid-luteal phase to determine CL location, and at 60 days post-insemination to determine fetal location. Ewes (n = 26) were bred to a fertile ram and reproductive tracts were collected at slaughter on days 12 - 19 after breeding. CL were weighed and frozen in liquid nitrogen for determination of mRNA expression of steroidogenic enzymes. In cows, unilateral right twins had the greatest number of follicles = 8 mm on the right ovary (2.4 ± 0.1 vs. 0.7 ± 0.1) and unilateral left twins had the greatest number of follicles = 8 mm on the left ovary (2.5 ± 0.1 vs. 0.8 ± 0.2) with bilateral twins intermediate in numbers of follicles for each ovary (1.8 ± 0.1 right vs. 1.5 ± 0.1 left; P < 0.0001). Bilateral double ovulation (n = 36) did not significantly increase pregnancy rate compared to unilateral double ovulations (61.1 vs. 50.9, P = 0.3), and there was no difference in follicle diameter or progesterone concentration and CL diameter during the luteal phase between unilateral and bilateral double ovulations. In ewes, there were no differences in pregnancy rate, CL weight, serum progesterone concentrations, or steroidogenic enzyme mRNA expression between bilateral and unilateral double ovulations. Bilateral double ovulations did not enhance pregnancy rates or luteal function as compared to unilateral double ovulations. From these data, we conclude that the number of follicle = 8 mm on each ovary at insemination may be an indicator of ovulatory phenotype.

Key Words: Fertility, Prolificacy, Ruminants

301 Relationship between concentrations of pregnancy-associated glycoproteins (PAG) in maternal blood and fetal number and status in pregnant cows. S. Echterkamp*¹, J. Green², K. Vonnahme³, R. Cushman¹, and M. Allan¹, ¹USDA-ARS, MARC, Clay Center, NE, ²University of Missouri, Columbia, ³North Dakota State University, Fargo.

The use of PAG and progesterone concentrations in maternal blood to determine fetal number in utero was evaluated in MARC Twinner cows

gestating one or two fetuses. Ovulation rate and fetal number were determined by ultrasonography at about 56 d postbreeding. Sequential jugular vein blood samples (10 ml) were collected by venipuncture at a mean interval of 56.6, 121.2, 191.6, and 233.6 d (range = ± 10 d) postbreeding (i.e., sample times 1, 2, 3, and 4, respectively). Plasma concentrations of PAG were measured by an indirect sandwich ELISA and of progesterone by RIA. Data were analyzed by Proc Mixed analysis; PAG data were log transformed. Progesterone concentrations were greater for cows gestating twins and increased (P < 0.01) between times 3 and 4. The increase in PAG between sample times 2 and 4 was greater in dams with twins, resulting in greater PAG concentrations for twins versus singles at times 3 and 4 (type of pregnancy × time; P < 0.01). Total birth weight was correlated positively with PAG concentrations at sample times 3 and 4 (r = 0.48 and 0.59; P < 0.01). It is postulated that greater blood PAG concentrations in cows gestating twins were the result of a larger uteroplacental mass, including increased numbers of PAG-secreting binucleate cells, whereas progesterone concentrations were associated with CL number. Variability in PAG concentrations within birth groups limits use of PAG measurements for diagnosis of twin pregnancies.

Table 1. Comparison of maternal plasma progesterone and PAG concentrations (ng/ml) between cows gestating single versus twin fetuses.

Type of pregnancy	n	Sample times				Pooled sem	Pooled Mean	Pooled sem
		One	Two	Three	Four			
Single	23	7.8	7.0	7.3	9.1	0.6	7.8a	0.4
Twin	17	9.3	8.3	8.6	11.0	0.6	9.3b	0.5
PAG								
Single	23	9.0	14.4	52.9a	125.7a	13.4	51.8a	9.3
Twin	17	11.1	16.2	116.4b	274.7b	15.9	104.6b	10.7

a,b Means differ between single and twin pregnancies; P < 0.01.

Key Words: Pregnancy-associated glycoproteins, Twins, Cattle

302 Proliferation and vascularity of different placental types in sheep. W. J. Arndt*^{1,2}, P. P. Borowicz^{1,2}, L. P. Reynolds^{1,2}, and K. A. Vonnahme^{1,2}, ¹Center for Nutrition and Pregnancy, Fargo, ND, ²Department of Animal and Range Sciences, Fargo, ND, ³North Dakota State University, Fargo.

The placenta is essential for the proper development of the fetus through its role in nutrient exchange. In ewes, placentomes have been reported as the classic convex shape (Type A) to a morphology similar to a bovine placental type (Type D), and transitional morphologies (Types B and C). It has been theorized that Type D placental types may be more vascular compared to Type A placental types. Our objective was to characterize numbers, sizes, cellular proliferation, and maternal vascularity of Type A, B, C, and D placental types from d 135 pregnant ewes. One hour before slaughter, 19 ewes were injected with BrdU. At slaughter, the uterus was collected and the uterine artery was perfused with Carnoy's fixative. Ewes that had at least 3 different placental types (n = 13) were used. Individual placental types were weighed, diameters measured, and types recorded. Fixed placental types were embedded in paraffin, sectioned, and stained for BrdU, Periodic-Acid Schiff's reagent, and hematoxylin to analyze proliferation and vascularity (i.e., capillary size, capillary area density (CAD), capillary surface density (CSD), and

capillary number density (CND)) by image analysis. Ewes had 60.3 ± 7.0 , 29.1 ± 5.0 , 10.9 ± 4.0 , and $9.2 \pm 4.2\%$ of Type A, B, C, and D placentomes, respectively. Type D placentomes were 2.5- to 2.7-fold heavier ($P < 0.01$) than Type A and B, and tended ($P = 0.09$) to be heavier than Type C placentomes. Type C and D placentomes were larger ($P < 0.01$) than Type A and B placentomes (3.9 ± 0.3 vs 2.5 ± 0.01 cm). There were no differences in cellular proliferation in maternal or fetal tissues by placentome type. While there was no difference in capillary size, CAD, CSD, or CND by placentome type, total CAD, CSD, and CND were greater ($P < 0.01$) in Type D placentomes compared to Type A, B, and C placentomes (1.8- to 3.7-fold for total CAD, 1.9- to 3.0-fold for total CSD, and 2.1- to 3.3-fold for total CND). It appears that size, not morphological type, is important for total vascularity of the placenta in the pregnant ewe. Supported by USDA NRI CSREES grant 2004-35203-14949 to KAV.

Key Words: Sheep, Placenta, Vascularity

303 Effects of estradiol (E_2) and linseed meal (LSM) on jejunal cellular proliferation in ovariectomized (OVX) ewes. M. O'Neil^{1,2}, G. Lardy^{1,2}, L. Reynolds^{1,2}, J. Caton^{1,2}, and K. Vonnahme^{1,2}, ¹Department of Animal and Range Sciences, Fargo, ND, ²North Dakota State University, Fargo.

LSM contains secoisolariciresinol diglycoside (SDG), a phytoestrogen (PE) proposed to have both estrogenic and anti-estrogenic properties. The presence of E_2 receptors in the small intestine has been confirmed and these tissues have been shown to respond to treatment with PE. The objective of the current study was to determine if feeding LSM will affect cellular proliferation in the jejunum. OVX ewes ($n = 48$) were fed a PE-free diet for four weeks (d -28 to d 0) following OVX to ensure the absence of any circulating endogenous estrogen or dietary PE. On d 0, OVX ewes were blocked by weight and randomly assigned to a control group (PE-free diet; CON; $n = 12$) or 12.5% LSM for 1, 7, or 14 d ($n = 12$ /group). Diets were based on beet pulp and formulated to provide similar amounts of energy (2.7 Mcal/kg) and CP (13.6%). On the last day of LSM feeding, OVX ewes were implanted with a subcutaneous E_2 implant (100 mg) for 0, 6, or 24 h. One hour prior to necropsy, ewes were injected with BrdU. A 150 cm section of the jejunum was dissected, weighed, and immediately perfused with Carnoy's solution, embedded in paraffin, sectioned, and stained to detect BrdU. Image analysis was used to quantify the percentage of proliferating cells in the jejunal crypts. There were no differences in 150 cm jejunal weights. There was a significant ($P < 0.01$) interaction between the LSM and E_2 treatments. In ewes fed LSM for 0 d and exposed to E_2 for 24 h cellular proliferation was increased ($P < 0.01$) from 0.86 to $2.36 \pm 0.34\%$. Feeding LSM for 1 d in the absence of E_2 tended to increase ($P = 0.11$) jejunal cellular proliferation from 0.86 to $1.61 \pm 0.34\%$. Feeding LSM for 1 d and exposure to E_2 for 6 or 24 h did not change the cellular proliferation rate as it had when LSM had been fed for 0 d. Feeding LSM for 7 or 14 d in the presence or absence of E_2 did not alter jejunal cellular proliferation rates from ewes fed PE diets with no E_2 exposure. The mechanisms causing the differential effects of LSM on the proliferation rate of the jejunum and LSM's interaction with E_2 require further investigation.

Key Words: Sheep, Phytoestrogen, Jejunum

304 Effects sustained release growth hormone on lambs at birth. J. Koch* and M. Wilson, *West Virginia University, Morgantown.*

During the first year of life, low birth weight lambs have a greater mortality, with the greatest percent of the mortality occurring in the first few days following birth compared to heavier lambs of the same age. Altering in utero growth and development to allow for heavier, more developed lambs at birth would decrease the high mortality rates a few days following birth. Altering the early embryonic environment may lead to late gestation alterations in organ and body development. The objective of this study was to determine effects of a single treatment of sustained release growth hormone (GH) on the lambs at birth. Ewes were synchronized using two injections of prostaglandin 8 days apart and the day of the second injection those ewes assigned to treatment received 500 mg of sustained release GH. All ewes were penned with a fertile ram. Upon lambing, all lamb birth weights (BW), crown rump lengths (CRL) and abdominal girths (AG) were determined and a serum sample collected to determine IGF-1 concentrations. Ram lambs were then euthanized to determine liver, heart and brain weights. A portion of the liver was snap frozen and used to determine IGF-1 and GH receptor mRNA utilizing real-time PCR. A portion of the base of the ventricles was removed to determine left and right ventricular wall thickness. Treated ewes gave birth to lambs with a heavier BW compared to control lambs (4.67 ± 0.07 vs. 4.08 ± 0.21 kg; $P < 0.05$). Lambs from treated ewes also had greater AG (31.6 ± 1.1 vs. 29.9 ± 0.7 cm; $P < 0.05$). However, there was no difference in CRL (50.2 ± 1.2 cm). Liver IGF-1 message was reduced ($P < 0.05$) in lambs gestated by ewes treated with GH compared to controls; however, there was no difference in liver GH receptor message. The left ventricular wall was thinner in hearts from lambs gestated in GH treated ewes compared to those from controls. There was a positive correlation between lamb BW and serum IGF-1 ($r=0.48$; $P < 0.05$). In conclusion, treating ewes with sustained release growth hormone not only increased lamb BW but also resulted in alteration in the growth and development of the lambs.

Key Words: Growth hormone, IGF-1, Gestation

305 Effect of nutrient restriction and dietary selenium (Se) on maternal and fetal organ mass in pregnant ewe lambs. R. Reddy^{1,2}, J. Reed^{1,2}, D. Redmer^{1,2}, L. Reynolds^{1,2}, K. Vonnahme^{1,2}, and J. Caton^{1,2}, ¹Center for Nutrition and Pregnancy, Fargo, ND, ²Department of Animal and Range Sciences, Fargo, ND, ³North Dakota State University, Fargo.

To determine the effect of nutrient restriction and dietary Se on maternal and fetal organ mass, pregnant Targhee ewe lambs ($n = 64$) were randomly allotted to one of eight treatments. At breeding, ewes were assigned to two levels of Se, normal Se (NSe; 0.3 ppm Se) or high Se (HSe; 3.0 ppm Se) diets. Se supplement was formulated using a Se yeast product. Each diet was similar in CP (13.8%) and ME (2.66 Mcal/kg). Ewes were fed 100% NRC requirements until d 50 of gestation. On d 50, ewes within each Se group were assigned to one of four nutritional levels for the remainder of pregnancy: Group 100/100 received 100% NRC from d 50 to d 130; Group 60/60 received 60% NRC from d 50 to d 130; Group 60/100 received 60% NRC from d 50 to d 90, thereafter 100% NRC from d 90 to d 130; and Group 100/60 received 100% NRC from d 50 to d 90 thereafter 60% NRC from d 90 to d 130 of gestation. On d 130 of gestation tissues were harvested and weighed. Data was evaluated for effects of nutrition and Se level on maternal organ wt

divided by maternal body wt (MBW; ewe wt minus uterine and digesta wt) and fetal organ wt divided by fetal empty body wt (FEBW; fetal wt minus viscera wt). There were no interactions. HSe ewes had increased ($P < 0.06$) perirenal fat/MBW and liver/MBW and decreased ($P = 0.07$) heart/MBW compared with NSe ewes. Group 60/100 ewes had increased ($P = 0.01$) liver/MBW compared with Group 100/60 and 60/60 ewes. Lung/MBW was increased ($P < 0.01$) in Group 60/60 ewes compared with all other groups. Group 60/100 and 60/60 ewes had increased ($P < 0.01$) small intestine/MBW compared with Group 100/100 and 100/60 ewes. Group 100/60 ewes had decreased ($P < 0.01$) pancreas/MBW compared to Group 60/100 ewes. While fetuses did not differ in crown rump length, Group 100/100 fetuses were heavier ($P < 0.05$) than all other groups (3891 vs 3480 ± 186 g). Group 60/60 fetuses had increased ($P < 0.05$) brain/FEBW compared to all other groups. Further research is needed to assess impacts of maternal nutrition during gestation on growth and production of offspring. Supported by USDA CSREES NRI Competitive Grant no. 2005-35206-15281.

Key Words: Sheep, Pregnancy, Nutrition

306 Characterization of variation in the weaning to interval for potential use with fixed timed AI. S. M. Breen* and R. V. Knox, *University of Illinois, Urbana.*

The weaning to estrus and estrus to ovulation intervals are variable and are influenced by follicle size, season, parity, and lactation length, and may impact fertility resulting from a longer insemination (AI) to ovulation interval. The weaning to ovulation interval (WOI) may be less variable but has not been well characterized. In addition, determination of factors influencing the WOI may allow for improved success with fixed timed AI. The objective of this study was to characterize the factors influencing the variation in WOI in sows using a retrospective analysis with WOI data from 7 studies performed during 1998 to 2005 ($n=786$). The analysis partitioned sows in groups receiving NO (0, $n=650$) or PG600 at weaning (PG, $n=136$) and NO (0, $n=548$) or GnRH at onset estrus (GN, $n=238$). The WOI was normally distributed ($P < 0.001$) and was 6.0 ± 0.9 d (mean \pm SD) with a 15% CV. Most sows (85%) ovulated on d 5-6.5 with 5% ovulating on d 2-4.5 and 10% on d 7-10 after weaning. PG advanced the WOI and skewed ($P < 0.001$) the distribution, compared to NO. GN at estrus did not affect the WOI ($P > 0.10$). Season influenced the WOI ($P < 0.005$) with spring shorter than winter and fall and similar to summer. There was no effect ($P > 0.10$) of parity on WOI. Lactation length impacted ($P < 0.005$) WOI and when > 18 d, WOI was shortened ($P < 0.01$) with increased variation in WOI in lactation lengths < 18 d. The average size of the largest follicles at estrus was not related ($P > 0.10$) to the WOI. These data suggest that ovulation time from weaning is less variable than predicting ovulation time based on estrus. Characterization of WOI is necessary in the development of timed AI systems that will need to correct for variation due to gonadotropin treatment, season, and lactation length.

Key Words: Sows, Ovulation, AI

307 Administration of androgens increase serum concentrations of fsh in gilts. E. Jiménez*, H. Cárdenas, and W. Pope, *The Ohio State University, Columbus.*

Thirty six gilts had a jugular vein cannulated and were assigned to one of six treatments: control (C; corn oil), 10 mg of testosterone (T), 10 mg of 5-alpha-dihydrotestosterone (DHT), 1.5 g of flutamide (F; an androgen receptor antagonist), T plus F and DHT plus F, per day. Beginning on d 13 (d 0 = 1st d of estrus), injection of hormones were given daily at 8:00 AM and blood samples were collected every h continuing until d 0. Gilts were mated with two different boars. On d 11, corpora lutea (CL) and blastocysts were counted following ovariohysterectomy. Serum concentrations of LH were determined hourly, FSH every 2 h and progesterone every 12 h. Data were analyzed using ANOVA and means compared using the PDIF option of SAS. Duration of the estrous cycle was shortened ($P < .05$) in gilts treated with T and T plus F (18.8 ± 0.3 and 18.7 ± 0.3 d, respectively) as compared with gilts in the C group (20.3 ± 0.3 d). Treating gilts with DHT numerically increased (25.0 ± 1.4 ; $P = .06$) the number of CL versus gilts receiving corn oil (21.0 ± 1.4). Embryonic survival was negatively ($P < .05$) affected in gilts treated with androgens but this effect was negated when gilts were co-treated with androgens plus flutamide. Treatment of gilts with either T or DHT increased ($P < .05$) the mean concentrations of FSH (1.8 ± 0.05 or 1.7 ± 0.03 ng/ml, respectively) as compared with gilts treated with corn oil (1.3 ± 0.03 ng/ml). Treatment with DHT plus F resulted in FSH concentrations that were not different than the C group and were less ($P < .05$) than the DHT group. This antagonistic effect of flutamide was also evident with T treatments. The mean concentration of LH in serum was greater ($P < .05$) only on d 13 in gilts treated with DHT versus T (treatment X d interaction; $P < .05$). There were no effects of treatments on serum concentrations of progesterone. Results indicated that one mechanism associated with the increase of ovulation rate in gilts treated with T or DHT might be stimulation of FSH secretion. (Support from USDA CRIS, grant number 2003-02712)

Key Words: Gilt, Androgen, Gonadotrophin

308 Placental expression of the membrane form of folate binding protein during pregnancy in swine. J. Vallet* and J. Kim, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

Previous experiments indicated that secreted (s) and membrane (m) forms of folate binding protein (FBP) are present in the intrauterine environment of the pig. Our studies indicated that the two forms are produced sequentially, the secreted form is present in the intrauterine glands until day 20 of gestation, while binding analysis indicated that placental folate binding increased dramatically in placental membranes until day 50 of gestation. However, the cell types expressing the membrane form of FBP have not been investigated. In this experiment, uterine wall sections from days 35, 50, 70, 90 and 105 of gestation were collected at slaughter and fixed in 4% paraformaldehyde in PBS. Samples were dehydrated through a graded series of alcohol and xylene and then imbedded in paraffin. Sections were cut (6 microns), placed on slides, and the slides were subjected to in situ hybridization analysis for mFBP using an ^{35}S -labelled probe that was specific to the 3' end of the mFBP mRNA. Slides were then dehydrated, dipped in NTB2 emulsion, dried,

allowed to expose for 2 weeks, developed, and counterstained with hematoxylin. Silver grains were clearly and uniformly evident over the placental epithelium, including both the tall columnar epithelium at the top of placental folds, and the cuboidal epithelium present in the sides and bottom of placental folds. The strength of labeling appeared to be uniform throughout gestation. These results indicate that the placenta expresses mFBP from day 35 of gestation onward, consistent with our previous folate binding results. This expression is consistent with the concept that sFBP and mFBP occur sequentially during gestation in swine, and that placental mFBP expression plays a role in folate transport after the placenta forms between day 20 and 35 of gestation. This project was supported by National Research Initiative Competitive Grant No. 2001-35203-11241 from the USDA Cooperative State Research, Education, and Extension Service.

Key Words: Folate, Placenta, In situ hybridization

309 Determining the impact of boar exposure and PG600 on follicle development, estrus and ovulation for potential improvement in estrus synchronization with MATRIX. A. Herdes*¹, S. Breen¹, C. Francisco², and R. Knox¹, ¹University of Illinois, Urbana, ²Intervet, Inc., Millsboro, DE.

Controlled estrus induction is advantageous for ensuring replacement gilts are at the proper stage of maturity when bred. The objectives were to obtain preliminary data on the impact of boar exposure (BE) and PG600 (PG) for use with Matrix programs. Experiment (Expt.) A and B were performed using prepubertal gilts ~175 days of age. Expt. A evaluated BE (n=3), PG (n=4), PG+BE (PGBE, n=3), and no treatment (C, n=3) from start of treatment (d 0) until d 7. All gilts were checked for estrus once/d using a boar. C gilts received no additional boar exposure, while BE gilts received 20 min./d, and PG gilts received PG600 on d 0 but no additional boar exposure, and PGBE gilts received PG600 on d 0 and an additional 20 min. of boar exposure/d. Ovaries were recovered to determine ovulation rate (CL). Expt. B was performed with the same treatments and response variables as in Expt. A with C (n=5), BE (n=5), PG (n=5) and PGBE (n=5). From d 20 to 40, all gilts were checked for estrus once/d and all gilts received Matrix for 14 d starting on d 40. Following last Matrix feeding, estrus detection continued until d 64. Reproductive tracts were collected 21 d later. Compared to C, PG and BE induced follicle growth by d 4, but had no effect on d 0 or 2. PG increased estrus and ovulation within 7 d and although BE did increase these responses, it did not differ from C. More PG treated gilts ovulated during the first estrus while < 15% of C gilts ovulated. Expt. B indicated that after 20 d of boar exposure, estrus in BE, PG and PGBE was 100% while only 33% in C. Following Matrix, 100% of animals expressed estrus and there appeared to be greater synchrony in treated gilts compared to C, but no differences in interval from last feeding to estrus. PG and BE increased number of CL compared to C. These data suggest BE and PG are important in stimulating follicular development, estrus and ovulation, but BE alone is less effective. BE and PG impact induction of estrus and could prove useful for selecting gilts earlier for fertility, advancing maturity and ovulation rate when used in concert with Matrix.

Key Words: Estrus, Ovulation, PG600

310 Expression of insulin receptor substrate-1 (IRS1) mRNA in hepatic tissue of periparturient Holstein cows. J. Meyer*¹, R. Radcliff², and M. Lucy¹, ¹University of Missouri, Columbia, ²Marshfield Clinic, Marshfield, WI.

Selection of dairy cattle for milk production is associated with insulin resistance during lactation. The objective was to measure IRS1 (an intracellular mediator of insulin action) in the liver of dairy cows during the periparturient period. Liver biopsies (n=80) were collected from 43 Holstein cows on each of days -14 to +14 relative to calving. Total cellular RNA was isolated and reverse transcribed into cDNA (SuperScript First-Strand Synthesis System, Invitrogen, Carlsbad, CA). The IRS1 mRNA amount was measured by using quantitative reverse transcriptase polymerase chain reaction with Syber Green detection. The forward (5'-AATGGTCACCGCTACGTGCCAG-3') and reverse (5'-CGCTCCAAGGGGTGCATTTC-3') primer sequences were designed from bovine sequence (GenBank XM_581382). The PCR reactions were performed and fluorescence was quantified with the ABI PRISM 7500 Sequence Detector (Applied Biosystems, Foster City, CA). Analyses of amplification plots were performed with the Sequence Detection Software (Applied Biosystems). The qRT-PCR amplified a 314 base pair product that was DNA sequenced and found to be identical to bovine IRS1. Data were expressed as fold difference relative to an internal control used within each reaction plate. There was no effect of day on the amount of IRS1 mRNA (P>0.10). The amount of IRS1 was 4.58 ± 0.89, 4.53 ± 0.87, 3.67 ± 0.87, and 5.06 ± 0.94 on day -14 to -8, -7 to -1, 0 to +7, and +8 to +14. The amount of IRS1 detected across cows was highly variable (CV=81.7%) with a greater than 50-fold difference in IRS1 expression from lowest to highest sample. The IRS1 mRNA amount was subjected to linear correlation with the amount of growth hormone receptor (GHR) 1A and total GHR (measured in previous studies of the liver samples). The fold changes in IRS1 were positively correlated with GHR1A (P<0.001; r²=0.15) and total GHR (P<0.001; r²=0.17). In conclusion, IRS1 mRNA amount was highly variable in liver and did not change with day relative to parturition. The r² between IRS1 and GHR mRNA were significant but small (less than 0.2).

Key Words: Dairy, IRS1, Liver

311 Utilization of dried distillers grains for developing beef heifers. J. Martin*, A. Cupp, R. Rasby, and R. Funston, University of Nebraska, Lincoln.

The objectives of this study were to determine if supplementing beef heifers with dried distillers grains (DDG) as an energy source affected age at puberty or reproductive performance. Spring-born crossbred heifers were blocked by sire and age (location one, n = 91) or age (location two, n = 79) and assigned randomly to DDG or CON treatments. The control supplement contained dried corn gluten feed, whole corn germ, and urea. Heifers received ad libitum prairie hay (11% CP, 54% TDN, location one; 8.4% CP, 53.9% TDN, location two), and either 0.57% of BW DDG or 0.73% of BW CON (DM basis). Diets were formulated to be isonitrogenous and isocaloric, however protein degradability differed. Supplemental UIP intake from DDG averaged 253 g•hd⁻¹•d⁻¹ and reached 301 g•hd⁻¹•d⁻¹, CON supplemental UIP intake averaged 92 g•hd⁻¹•d⁻¹ and peaked at 111 g•hd⁻¹•d⁻¹. Supplementation began 38 d after weaning for an average of 194 d. Initial pubertal status was determined by two blood samples collected 10 d apart. Weights and blood

samples were collected monthly for the first 3 mo and at 14 d intervals thereafter, with supplement intake adjusted accordingly. Heifers were synchronized with two injections of prostaglandin F_{2A} 14 d apart, heat detected for 5 d, inseminated 12 h after detection of estrus, and placed with bulls for approximately 50 d beginning 9 d after the final AI. Conception and pregnancy rates were determined via transrectal ultrasonography. Treatment did not influence initial wt (250 ± 26 kg), initial BCS (5.36 ± 0.34), final wt (377 ± 37 kg), final BCS (5.71 ± 0.35), ADG (0.68 ± 0.10 kg), or age at puberty (346 ± 56 d). Neither estrus synchro-

nization rate (78%) nor final pregnancy rate (89%) was affected by treatment. However, there was a tendency ($P = 0.07$) for more DDG than CON heifers to conceive to AI (71% vs. 56%, respectively). Supplementing beef heifers with DDG had no effect on ADG or age at puberty, and tended to improve AI conception rate compared to an isocaloric, isonitrogenous control diet.

Key Words: Dried distillers grains, Heifer development, Undegradable intake protein

Ruminant Nutrition - Feedlot Nutrition

312 Effects of feeding a beta-agonist on performance, carcass yield, quality, and economic value of cull cows. J. N. Carter*, D. D. Johnson, T. A. Thrift, and J. L. Foster, *University of Florida, Gainesville.*

Our objectives were to determine the effects of feeding a beta-agonist to cull cows on animal performance, lean meat yield, and carcass quality, as well as the economic viability of feeding cull cows in Florida. Ninety-two crossbred beef cows (11 yr \pm 1.8) were fed in a 2x2 complete randomized block design with dietary treatment and implant (trenbolone acetate plus estradiol) status as factors (2 replicates). One-half of all cows were fed only the basal diet (CON) for 90d; the remainder received CON for the first 55d, then a beta-agonist (BETA; 200 mg \bullet hd⁻¹ \bullet d⁻¹) was added for the last 35d. BW and BCS were obtained on d 0, 54, and 90. Four cows per treatment were randomly selected and harvested on d0 to obtain baseline values. The basal diet consisted primarily of soybean hulls, citrus pulp, cracked corn, wheat middlings, and cottonseed hulls and contained 87.6% DM, 14% CP (DM basis), and 79.5% TDN. Carcasses were harvested on d 92; carcass data were collected. On d0, cows were uniformly thin (BCS = 4.2 ± 0.3). Ending BW and BCS did not differ by treatment; ADG and total gain only tended to be increased (1.3 kg/d vs 1.2 kg/d, $P = 0.15$; 117.9 kg vs 105.5 kg, $P = 0.15$, respectively) for cows fed BETA. Among carcass yield measurements, BETA tended to increase ($P = 0.23$) HCW; no other carcass yield or quality results were different. Blood urea nitrogen (BUN; ten per treatment) values were not different initially; however, a significant dietary treatment by implant status interaction was observed. When the combination of BETA and implant was administered, BUN was lower ($P < 0.0001$) compared with the CON x implant combination. Carcass value was not significantly different due to treatment; however, carcass value was increased ($P < 0.0001$) by \$248.09 when cows were fed for 90d compared with selling cows thin at d0. Under these experimental conditions, carcass quality was not adversely affected when cows were fed the BETA diet; however, we did not observe any clear significant improvement in animal performance or carcass yield.

Key Words: Cows, Beta-agonist, Carcass quality

313 The effects of linseed oil and derivatives on live performance, carcass characteristics, and meat quality of finishing steers.

M. Quinn*, J. Drouillard, E. Loe, B. Depenbusch, A. Webb, and M. Corrigan, *Kansas State University, Manhattan.*

Holstein-Jersey steers (n=60, 452 \pm 2 kg initial BW) were utilized in a finishing study to investigate the effects of linseed oil and derivatives on

live performance, carcass characteristics, and meat quality. Steers were fed diets consisting of approximately (dry basis) 80% steam-flaked corn, 6% alfalfa hay, 5% corn steep liquor, 2.9% vitamin/mineral premix, 2.3% soybean meal, 2.2% feed additive premix, and supplemental fat. The treatments consisted of no supplemental fat (CON), 4% linseed oil (LO), 4% linseed oil treated with a non-regio specific lipase enzyme (LLO), and linseed soapstock (SS; equivalent to 4% oil). Oil supplements provided for the addition of lipid predominantly as triglyceride (LO), free fatty acids (LLO), or soaps of fatty acids (SS). Steers were blocked by initial BW and randomly assigned to 12 pens (5 animals/pen, 3 pens/treatment). Following finishing steers were shipped to a commercial abattoir where carcass data were collected following a 24 chill. Rib sections were removed from the right side of each animal, vacuum packaged, and aged for 14 days. After aging, steak samples were cooked and subsequently analyzed for composition of fatty acids. Final BW, ADG, and G:F were not different among treatments ($P > 0.05$). Cattle fed CON had greater dry matter intakes compared to those fed SS, LO, and LLO (8.5 vs 8.0, 7.8, and 7.0 kg/day, respectively; $P < 0.05$). There were no differences among treatments for HCW, dressing percent, longissimus muscle area, 12th rib fat thickness, marbling, KPH, yield grade, incidence of liver abscess, or percent dark cutters ($P > 0.05$). Compared to CON steers, those fed LO, SS, and LLO had 183%, 83%, and 62% greater concentrations of C18:3n3 fatty acids in rib steaks ($P < 0.05$). Steers fed LO diets yielded significantly greater levels of the trans-10 cis-12 isomer of conjugated linoleic acid when compared to LLO, SS, and CON. In general, LO was more effective than SS or LLO as a source of omega-3 fatty acids for deposition into carcass tissue.

Key Words: Omega-3 fatty acids, Linseed oil, Cattle

314 Supplementation of MINTREX[®]-Zn, -Cu, and -Mn to feedlot cattle reduced mortality, morbidity and improved carcass quality. M. Vazquez-Anon*¹, T. Hampton¹, T. Peters², J. McGrath³, and B. Huedepohl⁴, ¹Novus International, Inc, St Louis, MO, ²DeKalb, Kalona, IA, ³Amana Farms, Amana, IA, ⁴Veterinary Medical Center, Williamsburg, IA.

MINTREX[®]-Zn, -Cu, and -Mn are organic zinc, copper, and manganese sources, respectively, with 2-hydroxy-4(methylthio) butanoic acid (HMTBa) as the organic ligand. The objective of this trial was to evaluate the benefits of supplementing MINTREX-Zn, -Cu and -Mn to feedlot cattle with access to drinking well water that contains high levels

of sulfur (1700 ppm) and fed with relatively high levels of dietary S (0.33 % DM basis) from milling co-products. Six hundred and forty eight weaned calves with an average body weight of 191 kg were randomly allocated to 4 pens per treatment in a completely randomized design and fed a control diet or diet supplemented with 37, 17.5, and 15.2 ppm per day of organic Zn, Cu, and Mn in the form of MINTREX for the entire feedlot period. Average daily gain, feed intake and feed to gain ratio were not affected by treatment. However, cattle fed organic trace minerals in the form of MINTREX exhibited significantly lower mortality (4.7 vs 2.44 %; $P=0.05$) and morbidity (47.1 vs 37.8 %; $P=0.06$). Carcass quality was improved by significantly reducing the incidence of dark cutters from 3.59 to 0.77 % ($P=0.02$) and slightly redistributing fat deposition from kidney, pelvic, and heart area ($P=0.05$) to intramuscular fat ($P=0.1$). From this study, it can be concluded that supplementation of organic Cu, Zn, and Mn in the form of MINTREX to feedlot cattle with access to high sulfur water content improved health and carcass quality

®MINTREX is a trademark of Novus International, Inc.

Key Words: Trace minerals, Morbidity, Feedlot

315 The relationship between mitochondrial respiration and residual feed intake in Angus steers. W. Kolath* and M. Kerley, *University of Missouri, Columbia.*

The objective of this study was to further examine the relationship between mitochondrial respiration and residual feed intake which has been reported by our laboratory. Forty Angus steers were housed in partially covered feedlot pens and fed a common diet at ad libitum intake. Individual animal feed intake was recorded using the GrowSafe® feed intake system over a five-month period in order to calculate residual feed intake (RFI), a measure of efficiency. Animals ($n=18$) were selected for further study based on their RFI values into a high RFI ($RFI=1.35 \pm 0.37$; $n=6$), average RFI ($RFI=0.24 \pm 0.19$; $n=6$) or low RFI ($RFI=-1.24 \pm 0.67$; $n=6$) group. The selected animals were sacrificed and tissue samples were taken from the longissimus dorsi muscle in order to measure mitochondrial respiration, function and electron leak. No differences were observed between the high, average and low RFI steers in initial or final BW, ADG or carcass measurements; however, ADFI by the high RFI animals was 2.43 kg/d greater ($P < 0.01$) than the low RFI animals. Low RFI steers exhibited a greater ($P < 0.05$) rate of state two and three respiration, respiratory control ratio, and hydrogen peroxide production than high RFI steers when provided with glutamate or succinate as a respiratory substrate. The acceptor control and adenosine diphosphate: oxygen ratios were not different between the groups for either substrate. When hydrogen peroxide production was expressed as a ratio to respiration rate there was no difference between any of the groups, signifying that electron leak was not increased in any of the animals. We concluded that mitochondrial respiration rate is inversely related to residual feed intake and may potentially be a predictor of an animal's gain efficiency status.

Key Words: Mitochondria, RFI, Gain efficiency

316 Comparison of Holstein, Jersey, and crossbred twinner steers. J. Lehmkuhler, M. Ramos*, S. Arp, and J. Claus, *University of Wisconsin, Madison.*

A total of 105 steers were utilized to investigate the response to continuous feeding a high concentrate ration versus a phase feeding strategy. Jersey ($n=40$) and Holstein ($n=45$) steers were assigned to a diet containing 20% corn silage (HIGH) or a phase (PHASE) feeding program that contained three rations from approximately five months of age to harvest. Twenty steers derived from the Twinner beef herd were placed on the HIGH dietary treatment post-weaning until harvest for comparison of performance to the dairy steers. Carcass data was obtained following a 48-hr chill. Following harvest, strip loins ($n=25$) were obtained from five carcasses within each treatment and breed sub-group for shear force determination. Holstein steers had heavier initial weights than Jersey steers with Twinners having the heaviest on trial weight ($P < 0.05$). Initial weights were similar ($P > 0.05$) by design for dietary treatments within dairy breed. A significant ($P < 0.05$) dietary treatment response was observed for liveweight at the end of the first and second periods, first period ADG, overall ADG, and days on feed with HIGH being greater than PHASE in performance and fewer days on trial. Breed differences ($P < 0.05$) were observed between the dairy steers in performance data for all liveweight and gain variables with Holstein steers being heavier and gaining more rapidly than Jerseys. Twinner steers had an overall ADG similar ($P > 0.05$) to Holstein steers and greater ($P < 0.05$) than Jersey. Jersey carcasses were the lightest, had the highest percentage trim loss, least amount of backfat and lowest yield grade ($P < 0.05$) while Twinner carcasses had the lowest marbling score ($P < 0.05$). Strips from Holstein PHASE steers had lower ($P < 0.05$) shear force values than Twinner and were similar to all other samples. These findings support previous research indicating that Holstein steers outperform Jersey steers. Additionally, these data suggest that the feedlot performance of Twinner steers resembles that of Holsteins.

Key Words: Cattle, Feedlot, Ruminant

318 Evaluation of gender based protein requirements in feedlot cattle. C. Bailey*, G. Duff, S. Sanders, L. Baumgard, J. Treichel, and C. McMurphy, *The University of Arizona, Tucson.*

A 2x3 factorial design was utilized to ascertain the effects of three dietary protein concentrations on performance, carcass characteristics, and serum urea nitrogen (SUN) in finishing steers and heifers. Animals were blocked by gender ($n=9$) and randomly assigned to a diet containing 11.0, 12.5 or 14.0% CP ($n=6$). Animals were weighed and bled at 28 d intervals for 84 d, overall daily DMI, ADG, and G:F were calculated and SUN was analyzed as a repeated measure throughout the study. Following slaughter, carcass data was collected for HCW, dressing percent (DP), KPH, 12th rib backfat (BF), LM area, marbling score (MS), and yield grade (YG). Heifers consumed and gained less than steers ($P < 0.01$) and had lighter HCW ($P < 0.01$), less KPH ($P = 0.08$), lower MS ($P = 0.02$) and YG ($P < 0.01$) and numerically had less BF ($P = 0.15$). Dry matter intake ($P = 0.02$), ADG ($P = 0.05$), HCW ($P = 0.08$), and YG ($P = 0.09$) increased quadratically with increasing dietary protein. Hot carcass weight ($P = 0.02$), BF ($P = 0.04$) and YG ($P = 0.09$) increased linearly with increasing dietary protein. Gain:feed, DP, KPH, LM area and MS was not affected by dietary protein concentration and G:F, DP,

and LM area did not differ between genders. However, there was a gender x dietary protein interaction ($P = 0.01$) for G:F with steers being the most efficient at 12.5% CP, while heifers were most efficient at 14.0% CP. This could be a reflection of the heifers' overall advantage in leanness. Gender had no effect on SUN concentrations, but SUN increased linearly ($P < 0.01$) with respect to dietary protein concentrations and both linearly ($P < 0.01$) and quadratically ($P = 0.01$) increased with respect to time. In conclusion, quadratic responses in DMI and ADG indicate that a 12.5% dietary CP concentration is optimal for either steers or heifers during the finishing period.

Key Words: Beef cattle, Dietary protein, Gender

319 Effect of phase feeding protein on cattle performance and nitrogen mass balance. S. Quinn*, G. Erickson, T. Klopfenstein, R. Stowell, K. Vander Pol, and D. Sherwood, *University of Nebraska, Lincoln*.

A winter feedlot trial was conducted from November to May using 96 crossbred steer calves (294 ± 0.27 kg) to evaluate effects of balancing DIP and UIP dietary requirements on steer performance and N volatilization. Calves were stratified by weight and assigned randomly to 12 pens and one of two treatments. Treatments were 1) control diet formulated for 12.3% CP (CON) or 2) treatment diet, using the NRC model and phase-feeding formulated to balance DIP and UIP requirements, encouraging N recycling over the feeding period (PHASE). Diets consisted of 74% dry rolled corn, 8% wet corn gluten feed, 7% alfalfa hay, 6% supplement and 5% molasses. Nitrogen excretion was determined by the difference between N intake and individual steer N retention. Total N lost was calculated by subtracting soil corrected manure and runoff N from excreted N. Ammonia emissions were measured weekly during the last five weeks of the feeding period using forced air wind tunnels and a sulfuric acid trap for 30 minutes in each pen. There was no difference ($P = 0.11$) in ADG between CON and PHASE (1.62 and 1.67 kg, respectively). Steers fed PHASE had a greater ($P = 0.09$) G:F than CON steers (0.168 and 0.162, respectively). There were no significant carcass differences between CON and PHASE. As designed, cattle fed PHASE consumed less ($P < 0.01$) N and excreted less ($P < 0.01$) N than steers fed CON with N excretion of 30.1 and 27.2 kg/steer for CON and PHASE, respectively. The amount of manure N was similar ($P = 0.71$) and runoff losses were similar ($P = 0.55$) between PHASE and CON. N volatilization tended ($P = 0.11$) to be lower for PHASE fed steers compared to CON with 13.28 and 16.16 kg of N excreted lost for PHASE and CON, respectively. Ammonia emissions were not different ($P = 0.73$) between the CON and PHASE pens (29.51 and 32.46 g/hd/d) as measured by forced air wind tunnel. There was a significant effect of time across weeks ($P < 0.01$) for ammonia measured with the wind tunnel but no treatment by time interaction ($P = 0.24$). Phase feeding gave equal or better performance and tended to reduce N volatilization without impacting N removed in manure.

Key Words: Cattle, Nitrogen mass balance, Phase feeding

320 Summary of manure amounts, characteristics, and nitrogen mass balance for open beef feedlot pens in summer and winter feeding periods. W. F. Kissinger*, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln*.

Data from 18 experiments (244 pens; 2,038 steers) over 10 years were summarized to obtain accurate predictions of manure nutrients, runoff losses, and a long term comparison between summer and winter feeding periods in open feedlot pens. Dietary treatments varied across experiments, but were based on corn or corn plus byproduct finishing diets and were similar across season in 16 of 18 experiments. Mass balance experiments require nutrient intake, excretion, manure, runoff, and pen soil balance measurements to accurately measure nutrient flow. Manure was quantified wet, sampled, and samples composited for analysis. Experiments were either summer (May to September) or winter (November to May) feeding periods which averaged 128 and 166 d, respectively. Manure DM hauled was different ($P < 0.01$) between season, with 4.8 and 9.1 kg/steer/d hauled for summer and winter experiments, respectively. Quantities of OM, ash, and N were greater ($P < 0.01$) for winter than summer with 1.13 kg OM and 59 g/steer/d of N hauled in summer compared with 2.18 kg OM and 100 g N hauled in winter. Manure DM quantity hauled was variable ($CV = 47$ to 49%). Manure OM ranged from 0.3 to 2.6 kg/steer/d in summer and 0.4 to 3.8 kg/steer/d hauled in winter experiments; however, manure OM may be a better indicator of manure production because ash from soil contamination can have a marked impact on manure DM hauled. Summer pens averaged 2.7% of N excretion in pen runoff N, and 6.2% of OM excretion in pen runoff, while winter pens averaged 1.8% of N excretion and 1.9% of OM excretion in pen runoff. Average N volatilization was greater ($P < 0.01$) for summer feeding pens (69.0%, $CV = 21\%$) compared to winter (47.2%, $CV = 41\%$). These results provide quantity of manure nutrients removed from open feedlots and suggest that seasonal differences exist for manure OM and N amounts as well as losses through volatilization. Runoff losses, while controlled, are not a major route of nutrient loss in open feedlots.

Key Words: Beef feedlots, Manure characteristics, Nitrogen mass balance

321 Phosphorus balance in commercial feedlots and cost of distribution. W. F. Kissinger*¹, R. E. Massey², R. K. Koelsch¹, T. J. Klopfenstein¹, and G. E. Erickson¹, ¹*University of Nebraska, Lincoln*, ²*University of Missouri, Columbia*.

Phosphorus (P) balance was assessed in six commercial feedlots in eastern Nebraska (3 pens/feedlot; 6,366 cattle) for an annual cycle to determine P excretion relationship to manure P, manure and manure P amount, as well as cost of distributing P appropriately. Nutrient balance included DMI, and P intake, excretion, and manure P. An economic model was developed to evaluate cost and value of manure distribution with different dietary P, feedlot size, crops, application time, land availability, and equipment. For the economic modeling, feedlots ranging in size from 2,500 head to 25,000 head one-time capacities were used as case studies to calculate excretion amounts from cattle fed diets with a range of phosphorus. Diet P and cost of distributing manure were analyzed as well as land needed. P intake and manure P averaged 40.2 ($CV = 20\%$) and 30.1 ($CV = 49\%$) g/animal/d, respectively, which were

correlated ($r=0.56$; $P<0.01$). Manure DM and OM hauled was 5.3 (CV=83%) and 1.5 (CV=45%) kg/animal/d, respectively, for the average 123 d feeding period. For the economic comparisons, 50% of the land was assumed to be available surrounding the feedlot and an application for a 4-year cycle. If dietary P is 0.49% of diet DM, then distribution costs are \$0.90, \$1.20, and \$2.75 greater for a 2,500, 10,000, and 25,000 head feedlot, respectively, compared to dietary P of 0.29%. However, in each case, manure nutrient value offset the increased cost, assuming land availability. Area required for manure distribution increased from

530 to 1,000 ha, and 5,300 to 10,000 ha when dietary P increased from 0.29 to 0.49% dietary P for a 2,500 and 25,000 head feedlot, respectively. These results suggest that dietary P directly impacts manure P in commercial feedlots with approximately 90% recovery, but can be variable. As dietary P increases, distribution costs increase depending on size of feedlot and land availability, but this is offset by greater nutritive value of manure.

Key Words: Phosphorus, Beef feedlots, Distribution cost

Teaching and Career Development Symposium - Learning from Professional Associations and Campus Initiatives to Improve Undergraduate Education

322 American Society of Animal Science initiatives to support teaching and learning. D. Buchanan*, *Oklahoma State University, Stillwater.*

The American Society of Animal Science (ASAS) began, nearly 100 years ago, to give animal scientists a place to share research. It continues to serve that function effectively through meetings and the highly regarded *Journal of Animal Science*. Many members are faculty in academic departments with education responsibilities as well as research. The ASAS can, and should, provide service to such members. It has done so, traditionally, in a number of ways. The *Journal of Animal Science* continues to be a source of information to incorporate into teaching programs. Similarly, the annual meeting is a place for educators to learn about the latest advances and to share ideas. The Teaching and Extension programs have been venues for discussing education innovations. These still important opportunities are no longer enough. ASAS is losing members and part of that decline is from members with teaching and extension responsibilities who do not see a continuing membership advantage. The *Journal of Animal Science* is available to academic communities through a library subscription and the meetings do not provide sufficient membership incentive. However, animal science educators form a potential source of new members. In addition to faculty members at Land-Grant universities, there are teachers of animal science at four- and two-year institutions who need support. Such individuals could be well served by the expertise which exists within ASAS. There is a developing plan to start a teaching website. Such a site could have class notes as well as video and audio content. There could be links to Teaching and Extension websites. Peer-reviewed articles about teaching and learning could be included. This could be especially important as a place for scholarly teaching articles that do not fit the *Journal of Animal Science* model. Education workshops could be a larger component of the annual meetings. In general, more emphasis on scholarly aspects of teaching and learning is needed through the ASAS web site and at the meetings. This would provide much needed member services and, potentially, recruit new members to ASAS.

Key Words: Teaching, Learning, Scholarship

323 The Center for Excellence in Learning and Teaching at Iowa State University. C. Brooke* and B. Skaar, *Iowa State University, Ames.*

A center for the enhancement of learning and teaching was first established by the Iowa State University faculty in 1993. Then known as the Center for Teaching Excellence, the center had a small staff and focused on development for full time faculty. Following an external review in 2000 and a needs assessment survey the following year, the Center increased in size and expanded its audience to include non-tenure track faculty and teaching assistants as well as tenure track faculty. In July 2004, we reorganized as the Center for Excellence in Teaching and Learning (CELT). This name change reflects not only our emphasis on student learning but also the added components of the Center's work. Its mission is to support, promote, and enhance teaching effectiveness and student learning; encourage scholarship of teaching and learning; communicate the importance of teaching and learning to both internal and external audiences; and serve as a catalyst for learning centered education. To achieve this mission, CELT offers a wide array of educational experiences, grant opportunities and scholarly development tools to support the teacher and teaching scholar. One example program effort called Preparing Future Faculty is a learner-centered professional development opportunity to develop early career success in teaching. Numerous programs encouraging an increased emphasis on the scholarship of teaching and learning are offered by the CELT, with an emphasis on collaborative sharing of innovative pedagogical practice and technology use. The CELT also works collaboratively with other campus initiatives related to enhanced learning, such as learning communities, student outcomes assessment, learner academic success programs, and ISUComm which is a university initiative to enhance written, oral, visual and electronic communication ability of ISU students.

Key Words: Learning, Pedagogy, Teaching

324 Learning initiatives to improve undergraduate education at a research-oriented institution. R. Rastani* and M. Wattiaux, *University of Wisconsin, Madison.*

Research-oriented institutions strive to balance research with undergraduate education. Our objective was to determine the relative participation of the College of Agriculture and Life Science (CALs) in two learning initiatives, the Delta program (DP) and the Teaching Academy (TA) and to gauge their impact on undergraduate education at the University of Wisconsin-Madison. In the last 3 years, the DP, which is funded by the National Science Foundation, has had the mission of developing a national faculty in STEM (science, technology, engineering and mathematics) committed to implementing and advancing effective teaching practices for diverse student audiences as part of their professional careers. In contrast, the TA, which was created in 1993 by the Faculty Senate, is a University-wide organization with limited funding; its mission is to provide leadership to strengthen undergraduate, graduate and outreach teaching and learning. The DP is comprised of prima-

rily graduate students (55.1% of members), while the TA is comprised of primarily faculty (65.1% of members). For the DP, the involvement of faculty, instructional staff, graduate students and post-doc was 11.2 and 13.2% for CALs and STEM, respectively. For the TA, participation rate was 1.5 and 1.4% for CALs and the entire University, respectively. Both the DP and the TA have impacted undergraduate education directly and indirectly. The DP has directly impacted undergraduate education through an Instructional Materials Development class, where faculty team up with graduate students to focus on improving one aspect of teaching and learning in a course. In contrast, the TA's key program is the Summer Institute, which is a week-long program to assist in course development, curriculum assessment, and other topics relative to teaching and learning. In conclusion, participation in learning initiatives by CALs is similar to participation by others in the University; while these initiatives contribute in placing emphasis on undergraduate education, their impact remains limited.

Key Words: Learning initiatives, Undergraduate education, Teaching

Breeding and Genetics - Molecular and Quantitative Genetics

325 Power and precision of linkage disequilibrium mapping of QTL in outbred populations. H. Zhao*, R. Fernando, and J. Dekkers, *Iowa State University, Ames.*

Linkage disequilibrium (LD) analysis in a closed outbred population uses historical recombinations and is useful to detect and fine map QTL. The objective here was to study the power and precision of QTL detection using different LD mapping methods. A 9 cM chromosomal region was simulated with markers every 1.8, 1, 0.47 or 0.24 cM and a QTL at 4.5 cM. Founders were simulated using equi-frequent biallelic markers and uniquely numbered QTL alleles. After 100 generations (G100) of random mating with an effective population size (N_e) of 50, marker genotypes and phenotypes on a quantitative trait were generated on 100, 200, 500 or 1000 individuals. One QTL allele with a frequency closest to 0.5 and within 0.3 ~ 0.7 in G100 was chosen to be the mutant QTL allele (Q_m) and set to explain 2, 5 or 10% of phenotypic variance. To detect and map the QTL, phenotypic data for G100 were regressed on: (1) 1 marker, (2) 2 or 4 markers, (3) 2- or 4-marker haplotypes, and (4) probabilities of having Q_m given the haplotype of the most recent common ancestor of Q_m and the observed marker haplotypes by using 2, 4 or 6 markers. Empirical 1% thresholds were derived assuming no QTL effect. Based on 10,000 replicates, power to detect QTL increased more with sample size than with marker density and was similar between models. Comparing models (2), (3) and (4), accuracies of QTL position estimates for significant replicates were greatly improved by increasing marker density, but little affected by sample size. In general, mapping precision was greatest with 2 markers in the model and similar between models. Increasing N_e or number of generations (G) since mutation tended to reduce power but improve mapping precision. When marker allele frequencies in founders were simulated as random between 0.2 and 0.8, both power and precision decreased. The mutation model was robust to the choice of N_e , G and marker frequencies in founders. Power and precision for non-central QTL were similar to those for central QTL. Further work is in progress to finalize these conclusions by using only segregating markers in the last generation.

Key Words: QTL, Linkage disequilibrium mapping

326 QTL detection and marker-assisted composite line development. N. Piyasatian*, L. R. Totir, R. L. Fernando, and J. C. M. Dekkers, *Iowa State University, Ames.*

Efficiency of marker-assisted selection on multiple QTL for a trait with heritability 0.1 in a line-crossing program was evaluated based on cumulative (CR) and cumulative discounted response (CDR, 10% interest over 10 generations, starting from the F₂) and frequency of favorable QTL alleles. Eighteen chromosomes with five marker intervals of 20 cM that were informative for line origin were simulated, of which half had QTL with effects sampled from a normal distribution. Backward elimination regression was used for QTL detection with two thresholds ($A=0.05, 0.01$). Only significant QTL were included for genetic evaluation. The following selection criteria were compared with standard BLUP selection: S1=number of favorable marker alleles; S2=sum of BLUE of marker line-origin effects; S3=BLUE of markers plus BLUP of polygenic effects; S4 and S5=use of S3 for 2 (S4) or 3 (S5) generations, followed by standard BLUP selection. Interactions between generation and marker effects were also included in S2, S3, S4 and S5. Results were based on 50 replicates. With $A=0.05$, CR in the F₄ was up to 25, 12% greater than BLUP for S3 and S2, but 2% lower for S1. Extra gains declined over generations for all criteria. Results of CDR are in Table 1. Increases in QTL frequencies were greater with a more stringent threshold ($A=0.01$) and were slightly greater for S3 than for S2, S1, S4, S5 and BLUP with $A=0.05$ but considerably greater than BLUP with $A=0.01$. S4 gave similar CDR as S3 but at much lower genotyping costs. Results show that QTL detected by backward elimination regression in breed crosses can be used for subsequent selection within the cross, even using markers that are 20 cM apart.

Table 1. CDR (% of BLUP) for S1-S5 and the number of markers genotyped with two thresholds (A=0.05, 0.01)

A	S1	S2	S3	S4	S5	No. markers genotyped
0.05	46.7**	52.1**	66.2 ^{ns1}	64.1 ^{ns12}	65.6 ^{ns12}	21
0.01	33.0	33.1	64.8	64.0 ^{ns12}	65.0 ^{ns12}	9

**=Highly significant between thresholds ($p < 0.01$), ^{ns1}=Not significant between thresholds ($p > 0.05$), ^{ns12}=Not significant between thresholds and between S4 and S5 ($p > 0.05$)

Key Words: QTL detection, Marker-assisted selection, BLUP

327 Estimation of correlations between phenotype and gene expression in microarray experiments with non-random pooling.

W. Zhang*, A. Carriquiry, D. Nettleton, and J. C. M. Dekkers, *Iowa State University, Ames.*

Microarrays are widely used to measure the mRNA expression levels of thousands of genes simultaneously. In such experiments, mRNA samples are sometimes pooled across individuals to reduce cost or increase mRNA volume in the sample. We consider the problem of identifying transcripts whose abundance is correlated with phenotype for a quantitative trait of interest. We assume that the quantitative trait phenotype has been measured on all individuals but that cost considerations require us to measure mRNA expression levels in pools rather than individuals. We propose to form disjoint pools of individuals based on phenotype. In this design, the simple correlation between a pool's trait mean and a pool's measured mRNA expression level overestimates the correlation between phenotype and expression level. We first simulated phenotype and expression level as bivariate normally distributed data. Then we assume that a pool's measured mRNA expression level is the average of mRNA expression levels of all the individuals in the same pool (no technical variance). We use the EM algorithm to obtain a maximum likelihood estimator for the correlation between phenotype and expression (Table 1). Furthermore, our estimator can be used in a likelihood ratio test to determine whether gene expression level is correlated with phenotype. This information is useful to investigate which genes might be involved in the genetic pathway of the phenotypic trait.

Table 1. Comparison of the true correlation with the sample correlation from individual data and the MLE of the correlation from pool data: 50 pools, 10 individuals per pool, and 1000 simulation runs.

True correlation	Mean of sample correlation from individual data	S.E. of sample correlation from individual data	Mean of MLE correlation from pooled data	S.E. of MLE correlation from pooled data
0	0.004	0.006	0.004	0.006
0.3	0.299	0.006	0.306	0.007
0.6	0.600	0.004	0.609	0.007
0.9	0.899	0.001	0.901	0.003

Key Words: Microarray, Correlation, mRNA pool

328 Differential gene expression in male mice highly versus lowly fertile after heat stress.

K. Cammack*, H. Mesa, E. Antoniou, and W. Lamberson, *University of Missouri, Columbia.*

Congruent to livestock, fertility losses in male mice occur 18-28d post-heat stress as mature spermatozoa in d18-28 ejaculates would have been at developmental stages during heat exposure. The objective of this study was to identify genes differentially expressed in male mice highly versus lowly fertile 18-26d following heat stress. Mature male mice were exposed to heat stress ($35 \pm 1^\circ\text{C}$; $n=50$) or thermoneutral ($21 \pm 1^\circ\text{C}$; $n=10$) conditions for 24h and then hemicastrated (d1) to collect tissue for gene expression analyses. Two periods of mating tests followed, the first from d3-11 when no reductions in fertility were anticipated (2 females/male), and the second from d18-28 when variation in fertility was expected (8 females/male). Males were sacrificed at d29, and Period 2 pregnant females at gestational d17. Males were indexed by multiplying overall mean ovulation rate by pre-implantation survival and number of pregnant females by male. The five highest and five lowest ranking males were identified as heat stress resistant and susceptible, respectively. Resistant males were 61.2 units in the index, 57.6 total fetuses and 57.5% in pregnancy rate higher than susceptible males. Mouse NIA 15k microarray platforms were used to identify genes differentially expressed in control, resistant, or susceptible sires. Over 150 genes were determined as being differentially expressed ($P < 0.001$). Expression levels of two genes involved in chaperone activity (*Psm7* and *Idh1*), and three genes involved in catalytic activity (*Canx*, *Hspcb*, and *Tcp1*), were confirmed with quantitative PCR. Expression of genes implicated in catalytic activity was decreased in heat-stressed males, and to a greater extent in resistant males. Expression of genes involved in chaperone activity was similar in control and resistant males, but was upregulated in susceptible males. Results from this study suggest that low fertility after heat stress is related to differential expression of genes involved in the heat stress response.

Key Words: Fertility, Heat stress, Gene expression

329 Testing for interactions between Calpastatin and M-Calpain markers in beef cattle on tenderness traits.

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The objective was to assess the association of single nucleotide polymorphisms (SNP) at the calpastatin (CAST) and M-calpain (CAPN1) genes with meat tenderness and palatability traits. Three populations were used; a population from *Bos taurus* that included crossbred animals derived from Hereford, Angus, Red Angus, Limousin, Charolais, Gelbvieh, and Simmental (GPE7; $n = 539$). Another population from *Bos taurus* with *Bos indicus* influence that included crossbred animals from Hereford, Angus, Brangus, Beefmaster, Bonsmara, and Romosinuano (GPE8; $n = 580$). The third was *Bos indicus* population comprised from purebred Brahman (STARS; $n = 444$). Traits evaluated were meat tenderness measured as Warner-Bratzler shear force at 14 d post-mortem (WBSF; kg), and traits evaluated by trained sensory panels that included tenderness, juiciness, and beef flavor intensity. An SNP

at the CAST gene had a significant ($P < 0.003$) effect on WBSF and tenderness in the GPE7 and GPE8 populations. Animals inheriting the TT genotype had meat more tender than those inheriting the CC genotype. The marker at the CAPN1 gene was significant ($P < 0.03$) for tenderness in GPE7 and GPE8. Animals inheriting the CC genotype had meat more tender than those inheriting the TT genotype. Markers at the CAST and CAPN1 genes were associated with beef flavor intensity in the GPE8 population. Animals inheriting the CC genotype at CAST and the TT genotype at CAPN1 produced steaks with more intense beef flavor when compared to the other genotypes. An interaction between CAST and CAPN1 was detected ($P < 0.05$) for WBSF on GPE8. Markers developed at the calpastatin and M-calpain genes are suitable to be used in conjunction to identify animals with the genetic potential to produce meat that is more tender.

Key Words: Cattle, *Calpain*, *Calpastatin*

330 Estimates of genetic parameters for carcass traits in calf-fed or yearling-fed Simmental cattle. R. Tait, Jr.*¹, G. Rouse¹, D. Wilson¹, A. Hassen¹, and E. Pollak², ¹*Iowa State University, Ames*, ²*Cornell University, Ithaca, NY*.

The objective of this study was to determine any similarities or differences of heritabilities or genetic correlations of carcass traits between calf-fed and yearling-fed cattle. Data from 10,439 cattle with carcass data from the American Simmental Association were subdivided into two groups for analysis. If the contemporary group average age was 480 days or less, the group was considered calf-fed ($n = 7476$); if the contemporary group average age was greater than 480 days, the contemporary group was considered to be yearling-fed ($n = 2963$). Calf-fed cattle were adjusted to a 430-day endpoint; yearling-fed cattle were adjusted to a 525-day endpoint. Carcass traits analyzed were: USDA marbling score (MS), 12th rib fat thickness (FT), 12th rib ribeye area (REA), and hot carcass weight (HCW). Each group was analyzed using a 4-trait multiple-trait animal model that included fixed effects of harvest contemporary group and percent Simmental, with random effects of direct genetic and an error term. Calf-fed cattle had heritabilities of 0.38 ± 0.04 , 0.47 ± 0.05 , 0.38 ± 0.05 , and 0.45 ± 0.05 , for MS, FT, REA, and HCW, respectively. Yearling-fed cattle had heritabilities of 0.30 ± 0.06 , 0.10 ± 0.05 , 0.28 ± 0.07 , and 0.29 ± 0.07 for MS, FT, REA, and HCW, respectively. Calf-fed cattle showed genetic correlations between MS and FT, REA, and HCW of 0.39 ± 0.08 , -0.16 ± 0.09 , and 0.19 ± 0.09 , respectively. Yearling-fed cattle showed genetic correlations between MS and FT, REA, and HCW of 0.43 ± 0.21 , -0.15 ± 0.17 , and 0.04 ± 0.17 ,

respectively. This analysis indicates that genetics has a greater influence on phenotypic variation in calf-fed cattle, and management becomes more important as cattle are on feed longer. These results provide important information for the development of interactive feedlot selection indexes.

Key Words: Heritability, Beef, Carcass

331 Genetic factors influencing bovine respiratory disease in feedlot cattle. G. Snowden*, L. Van Vleck, L. Cundiff, and G. Bennett, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Bovine respiratory disease (BRD) is the most common and costly disease of feedlot cattle in the US yet the genetic components for resistance to this disease have not been examined. Therefore, this study's objective was to characterize genetic factors influencing the incidence of BRD in feedlot beef calves. Growth and health records of 18,112 feedlot calves from 12 different breed types over a 15 yr period (1987 to 2001) at the USMARC, Clay Center, NE were analyzed. Breed types consisted of nine pure breeds (Angus, Braunvieh, Charolais, Gelbvieh, Hereford, Limousin, Pinzgauer, Red Poll, and Simmental) and three composite breeds (MARC I, MARC II, and MARC III). Five breeds (Braunvieh, Pinzgauer, Red Poll, Simmental, and Limousin) were present only from 1987 to 1991. Hereford calves were fed from 1987 to 1999. Incidence of BRD varied across years with the highest incidences observed between 1987 and 1992 (18 to 44%) followed by a period (1992 to 2001) of lower incidences (5 to 14%). Morbidity was highest in Limousin (32%), Pinzgauer (35%), and Simmental (33%); and lowest in Angus (10%). Mortality related to BRD was highest in Red Poll (9%) and lowest in Angus (2%). The epidemiological pattern showed that incidence increased dramatically after 5 d, peaked within 14 d and remained high until approximately 80 d in the feed lot. After 110 d on feed the numbers of morbid calves observed per day were negligible. Components of variance for animal genetic effects and for breed by year interaction as an uncorrelated random effect were estimated using MTDFREML. The heritability estimate for resistance to BRD in the feedlot was low, 0.08 ± 0.01 . However, because BRD incidence is a dichotomous threshold trait, adjusted heritability for resistance to BRD on an underlying continuous scale was estimated to be 0.18. Development of an accurate and humane challenge for resistance to BRD would likely be a useful tool to use with selection to reduce BRD in the feedlot.

Key Words: Longevity, Selection, Shipping fever

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