

ABSTRACTS
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Animal Behavior, Housing and Well-Being

1 Impact of halothane sensitivity on mobility status and blood metabolites of HAL-1843-free pigs following an aggressive handling model. A. L. Marr¹, C. P. Allison^{*2}, N. L. Berry², D. B. Anderson¹, D. J. Ivers¹, L. F. Richardson¹, K. Keffaber¹, R. C. Johnson³, and M. E. Doumit², ¹ *Elanco Animal Health*, ² *Michigan State University*, ³ *Farmland Foods*.

The objective of this study was to determine if HAL-1843-free pigs, which respond abnormally to halothane anesthesia, are more susceptible to becoming non-ambulatory (NA) when subjected to an aggressive handling model, following transport (1100 km) and lairage rest (2 h). Halothane non-sensitive (HN; n = 33) and halothane sensitive (HS; n = 47) pigs were moved through a 36.6 m long aisle that was 2.1 m wide at each end and 0.6 m in the middle 18.3 m, in ten groups of eight animals. Pigs were briskly moved through a four-lap course and received a minimum of one electrical prod per pass. Prior to testing (Pre-Test), rectal temperature was measured, open mouth breathing and skin blotchiness were visually evaluated and a blood sample was collected. Following the test, pigs were returned to their pen and the same measurements were taken immediately (Post-Test) and 1 h later (1 h Post-Test; no blood sample). Seven HS and two HN pigs became NA during the model. No differences were observed between HS and HN for the number of prods per pig (P > 0.05), but HS pigs that became NA received more prods per pig (P < 0.05). Post-test observations indicated a greater number of pigs exhibiting open mouth breathing and skin discolorations than at the pre-test or 1 h post-test periods (P < 0.05) regardless of halothane status. No differences were observed in blood markers between HN and HS pigs (P > 0.05). However, pigs that became NA had elevated pre-test levels of creatine phosphokinase, lactic acid, glycerol, free fatty acids, ammonia, and blood urea nitrogen (P < 0.05). Collectively, these data suggest HS pigs are more susceptible to becoming NA. The elevated pre-test blood metabolites of pigs that became NA indicate that these pigs were in a hyper-metabolic state that predisposes them to becoming NA.

Key Words: Non-Ambulatory, Halothane Sensitivity, Handling

2 Steroid hormone profiles and brain monoamine oxidase type A (MAO-A) activity of buller steers. M.P. Epp*, D.A. Blasi, B.J. Johnson, J.P. Kayser, and D.M. Grieger, *Kansas State University*.

One grazing/feedlot field study was conducted to evaluate the steroid hormone profile and brain monoamine oxidase type A (MAO-A) activity of steers exhibiting characteristics attributed to the buller steer syndrome (BSS) in a feedlot environment. Sera were harvested from 600 crossbred steers of eastern Missouri origin 7 to 14 days before placement on five different intensive early stocked pastures (pre-grass, PG) in south central Kansas. In mid to late July of 2002, all steers were sent directly to a commercial feedlot in western Kansas (BW = 403 kg) where serum was again harvested from all steers (feedlot arrival, FA). Each pasture group was maintained as a separate pen. When removed from its home pen for exhibiting classical buller steer characteristics blood was collected from that animal (buller, BL) before movement to a separate pen. Sera used for steroid analysis was obtained randomly from the non-buller (control) steers. PG progesterone was depressed (P < 0.05) in sera obtained from BL as compared to control sera (0.34 ng/mL vs. 0.66 ng/mL). From FA to BL there was a reduction (P < 0.05) of progesterone in buller steers (0.36 ng/mL vs. 0.22 ng/mL). There was an increase (P < 0.01) of testosterone in buller steers from FA to BL (0.0042 ng/mL vs. 0.016 ng/mL). FA estrogen increased (P < 0.01) from PG in both buller and control steers. For the MAO-A analysis, brains were harvested from 12 BL and 12 control steers at a commercial packing plant. Brain MAO-A mRNA levels measured by the real-time quantitative polymerase chain reaction method (RTQ-PCR) was 74.5% higher (P = 0.03) in BL as compared to control steers. Western blots confirmed the presence of MAO-A protein in brain samples. Previous studies have shown that progesterone, estrogen, and androgens influence the activity of MAO-A. This study suggests that MAO-A activity, under potential influence of steroidal hormones in the steer brain, may be a plausible mechanism that induces BSS.

Key Words: Buller Steer Syndrome, Steroid Hormones, Monoamine Oxidase Type A

3 Social aggression and productivity of grower-finisher pigs in large groups. T. Samarakone*^{1,2} and H. Gonyou¹, ¹*Prairie Swine Centre Inc.*, ²*Department of Animal and Poultry Science, University of Saskatchewan.*

Our objectives were to assess the influence of large groups on aggression and subsequent productivity in grower-finisher pigs. Eight blocks, each comprising four pens of 18 pigs (SG) and two pens of 108 pigs (LG) on fully slatted floors (0.76 m²/pig) were studied. Initial body weights averaged 31.8±5.4 kg, with equal numbers of barrows and gilts in each pen. Pigs were fed from multi-space wet/dry feeders, with a pig to feeder space ratio of 9:1. Aggression was recorded for two hours starting 0, 24hr and 48hr following grouping. After 8 wk on test, a total of 200 pigs were re-grouped for 2 hr in groups of four to assess the effect of prior social experience (SG vs LG) on aggression with pigs from their own pen, and unfamiliar pigs from SG and LG. Pigs were weighed on wk 0, 2, 5, 7 and 11 to obtain average daily gain (ADG). Pig mortality, morbidity and body weight variation (CV) within the pen at the end of each block were evaluated. Average daily feed intakes (ADFI) were recorded for four blocks during wk 2 to 5 and wk 7 to 11. There was no difference in aggression between group sizes up to 48hr following grouping. Upon re-grouping at week eight, pigs derived from SG showed an increase in aggression towards unfamiliar pigs, compared to those derived from LG. ADG for the entire 11-wk trial was significantly higher for pigs in SG compared to LG (971 vs 955±4.7 g/d; P<0.05), but the only sub-period in which a difference was observed was from 0-2 wk (919 vs 833±14.2 g/d, SG vs LG, respectively; P<0.05). Mortality/ morbidity of pigs (8.4% vs. 6.2% for SG and LG) and CV at the end of each trial (9.6 vs. 10.3±0.34 for SG and LG) was similar for both group sizes. ADFI was not affected by the two group sizes. These results indicate that pigs in LG alter their social strategy, and the effect of group size on productivity is limited to the initial stages of the grow/finish period.

Key Words: Large Groups, Grower-Finisher Pigs, Growth and Behaviour

4 Changes in nursery pig behavior and growth rate based on aromatic enrichment and altered pen space. D. M. Finnigan*, B. R. Wiegand, G. Bachman, and K. Tudor, *Illinois State University.*

This research was conducted with the approval of the Illinois State University Animal Care and Use Committee. Nursery pigs (n= 256) were evaluated for growth performance and fighting behavior from the day of weaning for a period of 25 d in the nursery facility. Two trials (T1 and T2) of 128 pigs each were conducted to determine if changes in pen spaced, 0.27 m² (S1) vs 0.23 m² (S2), per pig and enrichment of the pen environment with fresh lavender would alter pig ADG, incidences of fighting, and duration of fighting at weaning. Previous research with humans has shown that certain aromatic herbs, including lavender, have a calming effect in young children. We hypothesized that lavender could also have a calming effect on the fighting behavior of nursery pigs at time of nursery pen population. Pigs were assigned to one of 16 pens by sex (barrows vs gilts). Pen was the experimental unit and each pen contained 8 pigs from different litters. T1 results indicated that pigs in the lavender enriched pens had lower (P = 0.004) ADG compared with pigs in the non-lavender pens. While there were no differences for the number of fights based on lavender treatments, the duration of fights was shorter (P = 0.03) for pigs in lavender enriched pens with mean values of 276 s vs 169 s of fighting time for non-lavender and lavender treatments, respectively. Furthermore, pigs provided S2 had lower (P = 0.05) ADG compared with pigs provided S1. No enrichment by pen space interactions were observed. T2 results did not indicate a difference in ADG or fighting behavior based on lavender enrichment. However, ADG was changed (P = 0.01) based on pen space with (0.39 kg/d vs 0.35 kg/d) for S1 and S2, respectively. Based on these data, the increase in pen space from 0.23 m² to 0.27 m² improves ADG performance in nursery pigs. The contrasting responses to aromatic enrichment could be accounted for in the strength of the lavender aroma present in the nursery room.

Key Words: Nursery Pigs, Behavior, Enrichment

5 Effect of sorting, removal and remixing of heavy pigs on finishing pig performance. M. C. Brumm*¹, L. J. Johnston², D. W. Rozeboom³, and NCR-89 Committee on Swine Management, ¹*University of Nebraska*, ²*University of Minnesota*, ³*Michigan State University.*

A cooperative study was conducted with 450 crossbred pigs (31 kg initial wt; 6 replicates/treatment) at three research centers to evaluate the effect of remixing the heaviest pigs into new pens on overall pig performance to slaughter. Treatments included: 15 pigs/pen from initial wt to slaughter (15S), 20 pigs/pen from initial wt to 73 kg BW and then reduced to 15 pigs/pen to slaughter (20/15) and 15 pigs/pen from 73 kg BW to slaughter comprised of the five heaviest pigs from each of three 20/15 pens per replicate (15M). Space allocation in all treatments was 0.56 m²/pig to 73 kg and 0.74 m²/pig thereafter. There was no effect of treatment on ADG or GF before 73 kg BW. Least square means for ADG, ADFI and GF from sorting to first pig removal from a replicate for slaughter at 113 kg were 0.918, 0.945 and 0.941 kg/d; 2.882, 2.891 and 2.982 kg/d; and 0.322, 0.329 and 0.319 for 20/15, 15M and 15S treatments, respectively (P > 0.1). There was no effect (P > 0.1) of sorting on the coefficient of variation in pig weight within a population, either at the time of sorting or when the first pig was removed for slaughter. Using the Kruskal-Wallis test for nonparametric data, there was no difference (P > 0.1) in the weight distribution curves in the sorted versus the unsorted populations when the first pig was removed at 113 kg BW. However, sorting reduced the within pen weight CV at sorting (7.7% + 3.1% vs 9.1%; P = 0.002) and at first removal (7.1% + 4.0% vs 8.3%; P = 0.002) for the 20/15 +15M vs 15S treatments, respectively. These data suggest that sorting the heaviest pigs from a population into a new social group midway through a feeding period reduced within pen weight variation. However, sorting had no effect on subsequent growth performance or variation in final BW distribution of the entire population.

Key Words: Sorting, Mixing, Pigs

6 Developing a model to determine floor space requirements for pigs. H. W. Gonyou*¹, J. Dean², J. J. McGlone³, P. L. Sundberg⁴, M. Brumm⁵, H. Spoolder⁶, J. Kliebenstein⁷, B. Buhr², and A. K. Johnson⁴, ¹*Prairie Swine Centre*, ²*Univ. Minnesota*, ³*Texas Tech. Univ.*, ⁴*National Pork Board*, ⁵*Univ. Nebraska*, ⁶*Res. Instit. Anim. Husb.*, ⁷*Iowa State University.*

A model for predicting the effect of floor space allowance on productivity in pigs was developed based on the allometric relationship between body weight (BW) and surface area, and a modification of broken line analysis. Space allowance was expressed as k=A/BW.667, where A is in m², and BW is in kg. It was hypothesized that productivity would be maximized at levels of k above a critical value, and that average daily gain (ADG) would decrease in a linear relationship with k at levels below that value. To test this hypothesis, data from 7 peer-reviewed articles that met the following criteria were analyzed: grower-finisher pigs, fully slatted floors, final k values could be determined, ADG for the final 2-4 weeks were reported, and treatments resulted in final k values both above and below 0.031. To standardize values across reports, ADG for all treatments within a study were indexed against a value of 100% assigned to the most spacious treatment. The resulting critical value for k was 0.0329, with a slope of 1053 (r²=0.94). An additional three sets of data that met less stringent criteria were analyzed. Studies that only reported overall ADG, not restricted to the final 2-4 weeks, were included. For grower-finisher pigs on fully slatted floors, the critical k value was 0.0327, with a slope of 1067 (r²=0.52). For grower-finisher pigs on partially slatted floors, the critical k value was 0.0337, with a slope of 696 (r²=0.39). For nursery pigs, the critical k value was 0.0315, with a slope of 1018 (r²=0.56). In all cases the model explained a significant proportion of the variation and yielded a critical k value within 5% of the initial analysis. It is concluded that the model is robust and can be applied to data from a variety of management conditions.

Key Words: Pigs, Space Allowance, Model

7 Supplementation with daidzein has little effect on the weaned pig's response to a lipopolysaccharide challenge. T. A. Strauch* and J. A. Carroll, *Animal Physiology Research Unit, Agricultural Research Services-USDA.*

Objectives were to determine the effects of supplementation of daidzein, a phytoestrogen implicated as a cancer preventive, to weaned pigs on growth and response to a lipopolysaccharide (LPS) challenge. Forty crossbred barrows were removed from their sows and allowed a 5 d period to acclimate to new housing and dry feed. Pigs were weighed, individually penned, and assigned to daidzein (D; n=20) or control (C; n=20) treatment. The D pigs received 50 mg/d daidzein hand-fed in dough balls, and C pigs received dough balls without D. On d 14, pigs were weighed, non-surgically cannulated in the jugular vein, and assigned to rectal temperature (RT) measurement (n=10 D, 10 C) or blood collection groups (n=10 D, 10 C). The next day, blood samples and RT were collected at 30 min intervals from -1 to 4 hr post-LPS. At time 0, all pigs received a 50 µg/kg dose of LPS through the jugular cannulae. Serum was collected from blood samples and assayed for cortisol concentration by RIA. Data for BW, ADG, serum concentrations of cortisol, and RT were analyzed using ANOVA in StatView. There was no difference ($P > 0.72$) in initial BW, with average BW of 8.36 ± 1.13 and 8.24 ± 0.93 kg for D and C pigs, respectively. There was no difference ($P > 0.50$) in final BW, with average BW of 15.30 ± 2.30 and 15.73 ± 1.65 kg for D and C pigs, respectively. Accordingly, there was no difference ($P = 0.18$) in ADG (0.46 ± 0.10 kg/d D; 0.50 ± 0.07 kg/d C). There was no treatment by time interaction ($P > 0.66$) for serum concentrations of cortisol; however, there was an effect of time ($P < 0.0001$), with cortisol concentrations increasing over time. Similar to cortisol, RT increased ($P < 0.0001$) over time in both D and C pigs. There was a trend ($P < 0.12$) for decreased RT in D as compared to C pigs, with RT decreasing in D pigs by 4 hrs post-LPS as compared to C pigs that demonstrated no decrease in RT by 4 hrs post-LPS. This study demonstrated no beneficial protection against an immune challenge from daidzein supplementation.

Key Words: Daidzein, Fever, Lipopolysaccharide

8 Growth performance, hormone profiles, and behavioral responses following castration of piglets. E. L. Berg¹, J. A. Carroll², and T. A. Strauch², ¹*Department of Animal Sciences, University of Missouri,* ²*Animal Physiology Research Unit, ARS-USDA.*

The objectives were to determine the effects of castration in pigs at 3, 6, 9, or 12 d of age on acute growth performance, hormone profiles, and behavior. Ninety intact male pigs were randomly assigned a treatment age by litter (3, 6, 9, or 12 d of age; n=9-13 pigs/treatment/group). Pigs within a litter were then assigned to castrated (C) or non-castrated (N) treatment groups according to body weight. Pigs were non-surgically fitted with jugular catheters and blood samples drawn immediately prior to castration at time 0, and at 0.5, 1, 1.5, 2, 24 and 48 h post-castration. Body weights were obtained when the pigs were catheterized and at 24 and 48 h post-castration. Serum samples were analyzed for cortisol and dehydroepiandrosterone sulfate (DHEA-S). No differences ($P=0.88$) existed in initial body weight of pigs, and there was no overall treatment effect on growth performance of pigs at 24 h ($P=0.98$) or 48 h ($P=0.94$) post-treatment. There was a time by treatment effect ($P<0.01$) on serum cortisol concentrations, such that cortisol was greater in C pigs compared to N pigs. There was no overall age effect of castration on serum cortisol ($P=0.59$). At 24 h post-castration, serum cortisol returned to baseline in all treatment groups ($P=0.24$). However, at 48 h post-castration overall serum cortisol was elevated ($P<0.01$) in pigs as compared to baseline concentrations. There was a time by treatment by age interaction ($P<0.01$) for serum DHEA-S such that serum DHEA-S decreased in C animals and increased in N animals, and DHEA-S concentrations increased with age. During the first 2 h post-castration, there were no differences ($P>0.05$) found between the time C and N pigs spent nursing, lying, standing or sitting, although there was a trend ($P=0.08$) for C pigs to be less active than N pigs. These data indicate that castration is stressful regardless of age and that stress associated with handling appears to increase as the pig ages.

Key Words: Pig, Castration, Stress

9 Injury levels in sows housed in pens with electronic sow feeder (ESF) during gestation. L. Anil*¹, S. S. Anil*¹, S. K. Baidoo², J. Deen¹, and R. S. Morrison³, ¹*Clinical and Population Sciences, University of Minnesota,* ²*Southern Research and Outreach Center, University of Minnesota,* ³*West Central Research and Outreach Center, University of Minnesota.*

A study was conducted at the Southern Research and Outreach Center, University of Minnesota, Waseca, MN to describe the injury levels (frequency and severity) of sows housed in pens with electronic sow feeder (ESF) at different stages of gestation and its association with body weight and parity. One hundred and fifty four sows (parity 1- 4, body weight 171-259 kg) were housed (38-39 sows/group) in pens with ESF (12.75m X 6.75m, fully slatted floors, single ESF) during gestation. Injuries on various body parts, body weight and backfat thickness were measured on days 5, 19 (mixing days), 28, 56, 84 and 108 of gestation. Median total injury score (TIS) for the entire gestation period for sows was 20 (range 1-41). There was significant difference (Non-parametric Kruskal-wallis ANOVA, $P<0.05$) in TIS at different stages of gestation. The TIS was the highest at mixing days, followed by a reduction on days 28 and 56 and increase towards late gestation (days 84 and 108). The TIS on the day of second mixing was not significantly different ($P>0.05$) from that on day 108 of gestation. A chi-square test indicated that the frequency of injuries of different severities in various body parts were significantly associated ($P<0.05$) with stages of gestation with the exception of injuries on forehead and tail. Higher percentage of injuries was on neck, shoulder, thorax, croup-hindquarters and limbs. Severe and obvious injuries were higher ($P<0.05$) at the time of mixings. As gestation advanced severity (obvious and severe) of injury decreased on all body parts with the exception of udder and vulva where it increased towards late gestation (days 84 and 108) stages. As parity increased the likelihood for higher TIS decreased significantly ($P<0.05$). TIS was negatively and significantly correlated ($P < 0.05$) with body weight and backfat. The study revealed that mixing and competition for feeder entry were responsible for injuries in gestating sows in pens with ESF and was influenced by parity and body weight.

Key Words: Gestation, Sow, Injury

10 Injury levels in stall-housed sows during gestation. L. Anil*¹, S. S. Anil*¹, S. K. Baidoo², J. Deen¹, and R. S. Morrison³, ¹*Clinical and Population Sciences, University of Minnesota,* ²*Southern Research and Outreach Center, University of Minnesota,* ³*West Central Research and Outreach Center, University of Minnesota.*

A study was conducted at the Southern Research and Outreach Center, University of Minnesota, Waseca, MN to describe the level of injuries of stall-housed sows at different stages of gestation and its association with body weight and parity. One hundred and forty four sows (parity 1-5, body weight 140-278kg) were housed in conventional gestation stalls (length 200cm x width 60 cm x height 97 cm, fully slatted floor) during gestation. Injuries, body weight and backfat thickness were measured 4 days before weaning and on days 5, 28, 56, 84 and 108 of gestation. Median total injury score (TIS) for the entire gestation period was 5 (range 1-16). TIS was significantly (non-parametric Kruskal-wallis ANOVA, $P<0.05$) higher at day 108 and there was no significant ($P>0.05$) difference in TIS at other stages of gestation. Chi-square test indicated that presence of injuries on face, snout, forehead, ears, neck, hind limbs and tail did not show significant ($P>0.05$) changes with advancement of gestation. Injuries on flank, thorax, top of the back, croup-hindquarters, forelimbs, vulva and udder significantly increased as gestation advanced ($P<0.05$). Injuries on the shoulder significantly ($P<0.05$) reduced as gestation advanced. Top of the back and udder had highest percentage of injuries on day 108. As parity increased the likelihood for higher TIS increased ($P>0.05$). TIS was positively and significantly correlated with body weight and backfat ($P<0.01$ for both). The findings of the present study confirmed that injuries in stall-housed sows were associated with the body size of sows relative to the stall size. Injuries increased with increase in body size consequent to advancement of gestation. Increasing the stall dimensions relative to sow size would be beneficial for the welfare of large sows.

Key Words: Gestation Stall, Sow, Injuries

11 Analysis of lameness in swine breeding herds. S. S. Anil*, L. Anil*, and J. Deen, *Clinical and Population Sciences, University of Minnesota*.

A retrospective analysis involving removal parity records of 52,369 sows and gilts from 11 herds was performed to characterize the removal pattern due to lameness. The parity at removal was categorized into 3 levels (parity 0=P0; parity 1=P1; parity ≥ 2 =P ≥ 2). Within each removal parity category the removal types (cull, death and euthanasia) and removal reasons were assessed. The major removal types for all sows and those sows removed due to lameness were analyzed based on the farrow to removal interval. Culling was the major removal type and a higher proportion of P0 females than P1 and P ≥ 2 sows were culled. Removal due to death and euthanasia was lower in P0. The percentage of animals removed for lameness was higher than that removed for the majority of other removal reasons with the exception of productive and reproductive reasons. A higher percentage of P1 sows (14.89) was removed for lameness compared to P0 (10.22) and P ≥ 2 sows (9.91). By 20 days post-farrowing, 41 per cent of deaths, 39 per cent of euthanasia and 11 per cent of culling were observed. Within 10 days post-farrowing, 20 per cent of the deaths in P1 lame sows occurred and the proportion of the deaths increased to 37 percent in the next 10 days. 40 per cent of euthanasia for lameness had occurred within 20 days post farrowing and culling percentage of P1 lame sows at this time was 23. The percentages of deaths, euthanasia and culling among P ≥ 2 lame sows were 45, 41 and 24 respectively by 20 days post-farrowing. The high proportion of death among lame sows immediately preceding farrowing indicated that welfare status of these sows was poor and they were being retained for too long until farrowing and lactation. The study indicated that an adequate and timely culling strategy could reduce sow mortality and improve sow welfare.

Key Words: Sow, Lameness, Welfare

12 Preference of dairy cows for free stalls bedded with sand or granite fines, and changes in bacterial counts in those materials. R. Panivivat*¹, E. B. Kegley¹, D. W. Kellogg¹, J. A. Pennington², K. VanDevender², D. H. Hellwig³, T. J. Wistuba⁴, and S. L. Krumpelman¹, ¹University of Arkansas, ²University of Arkansas Cooperative Extension Service, ³Berea College, ⁴Morehead State University.

Granite fines are less expensive than sand, so the objective of this trial was to compare these materials as bedding in free stalls for lactating cows. Free stalls (n=18) were randomly assigned to be bedded with either granite fines or sand. Lactating cows (100 to 160 cows, 31 to 90 d in milk) had access to these stalls plus 142 others bedded with sand in an open sided barn. Experimental stalls were observed on 6-d (4 times/d) during the 27-d study. Using a logistic procedure, experimental stalls bedded with sand were 2.8 times more likely to be used than stalls bedded with granite fines (P < 0.01). Stall usage data were analyzed using a frequency procedure (P < 0.01); cows were observed lying on sand 61% of the time and were standing on granite fines 67% of the time. On d 24, hardness of the surface, measured at a pressure of 2 kg/cm², was greater for granite fines than for sand (P < 0.05). Bedding material by time of sampling interactions (P < 0.05) were evident for gram-negative bacteria and *Streptococci* counts. Before addition to the stalls, gram-negative bacteria were non-detectable in granite fines, but were present in sand. On d 1 after adding new material to the stalls, numbers of gram-negative bacteria did not differ between materials. However, *Streptococci* counts in stalls bedded with granite fines were lower than those for stalls bedded with sand. On d 7 and 11 after adding new materials, both gram-negative bacteria and *Streptococci* counts in granite fines were greater than those in sand. *Klebsiella spp* counts were higher (P = 0.06) in the stalls bedded with granite fines. Cows preferred sand compared to granite fines in free stalls, possibly due to the softer bedding surface, and some bacterial counts were lower in stalls bedded with sand.

Key Words: Cow preference, Bacterial counts, Bedding materials

Breeding and Genetics

13 Prediction of inheritance for cranial cruciate ligament disease in the Newfoundland dog. V. L. Wilke*¹, B. P. Kinghorn², M. G. Conzemius¹, and M. F. Rothschild¹, ¹Iowa State University, ²University of New England, New South Wales.

Cranial cruciate ligament disease (CCLD) is the leading cause of lameness in the dog. Rupture of the CCL causes instability in the knee leading to debilitating arthritis and lameness. Our objectives were to determine the incidence of CCLD in Newfoundlands presented to Iowa State University College of Veterinary Medicine (ISU-CVM), determine the coefficient of inbreeding for a population of Newfoundlands (NEWF), and determine the mode of inheritance for the disease. For the first objective, medical records from collected from the ISU-CVM for all NEWF that were seen for care from 1996 through 2002. All records were systematically evaluated for evidence of CCLD. For the remaining objectives, a large scale recruitment study was performed to collect five generation pedigrees from NEWF. NEWF were examined by a veterinarian and classified as cruciate affected status based on signs consistent with CCLD. These signs included pain on hyperextension of the knee, knee swelling, decreased knee range of motion, knee instability, radiographic evidence of knee arthritis, and/or surgical confirmation of a ruptured cranial cruciate ligament. Pedigrees were constructed using Pedigraph version 1.1, inbreeding coefficient determined using SAS, and a segregation analysis was performed. One hundred sixty three NEWF presented to ISU-CVM of which 22% of the NEWF were diagnosed with CCLD. Pedigrees were collected on 267 NEWF, of which 56 (33 female, 23 male) were affected and 211 (109 female, 102 male) were normal dogs. The average inbreeding coefficient was 0.0018 in the entire pedigree population. The average inbreeding coefficient for the animals that were inbred was 0.05 (range 0.004 - 0.17). Iterative segregation analysis revealed a recessive pattern of inheritance with the frequency of recessive allele being 0.65 and with 59% penetrance. Many different causes for CCLD in the dog have been proposed, but this is the first study that has defined the genetic basis of this disease in the Newfoundland breed.

Key Words: Newfoundland, Cranial Cruciate Ligament Disease, Genetics

14 Relationships between body temperature and performance traits in heat-stressed rats. K. M. Cammack*, D. E. Spiers, P. A. Eichen, and W. R. Lamberson, *University of Missouri*.

Identification of an easily measurable phenotypic trait indicative of heat stress response in pre-pubertal animals that is highly correlated with post-pubertal response would allow for early selection of heat tolerant animals. Sprague Dawley rats (n=38) were implanted with telemetric core temperature transmitters to monitor body temperatures. Rats were exposed to daily cycles of 14 hours of darkness in heat stress temperature (34 \pm 2degC) and 10 hours of light in thermoneutral temperature (21 \pm 2degC) during pre-pubertal (28-35d) and post-pubertal (55-62d) periods. Body weights and feed intake were recorded daily. Correlations were estimated between traits measured during pre-heat stress (Period 1), pre-pubertal heat stress (Period 2) and post-pubertal heat stress (Period 3). Correlations more extreme than -0.32— are significant at P \leq 0.05. Daily average temperature (DT) prior to heat stress was moderately and positively correlated with DT during heat stress (r = 0.45 and 0.30 between Period 1 and Periods 2 and 3, respectively). The correlation of DT between Periods 2 and 3 was 0.81. Correlations estimated between average daily feed intake (DFI) prior to heat stress and DFI during heat stress were low and negative (r = -0.03 and -0.27 between Period 1 and Periods 2 and 3, respectively). However, pre- and post-pubertal measures of DFI were highly correlated (r = 0.93). Similar results were found for average daily gain (ADG). These results suggest that DFI and ADG are different traits during heat stress versus thermoneutral conditions. The high positive correlations estimated between Periods 2 and 3 for DT, DFI and ADG indicate post-pubertal heat tolerant individuals can be selected during pre-pubertal heat stress. Period 2 DT correlation estimates with Period 2 DFI and ADG were -0.53 and -0.58, respectively. Similar estimates were found between Period 2 DT and Period 3 DFI and ADG. Therefore, individuals with lower DT during pre-pubertal heat stress conditions should have increased DFI and ADG both pre- and post-pubertally.

Key Words: Rats, Heat Stress, Body Temperature

15 Detection of quantitative trait loci for growth, carcass and meat quality traits in pigs. T. Stearns*, J. Beever, M. Ellis, F. McKeith, and S. Rodriguez-Zas, *University of Illinois*.

A pig F2 population was used to identify QTL for growth, carcass and meat quality traits. A total of 811 F2 offspring that resulted from a parental cross between three Berkshire grand sires and 18 Duroc grand dams together with the F1 and parental populations were genotyped for ten markers on chromosome 6 with an average spacing of 17.1 cM. Animals were weighted from birth to slaughter at approximately 125 kg every 21 d. Phenotypic data included: live weights, first, tenth, last rib and average backfat thickness, leanness, marbling, and tenderness. The fixed effects included in the model were: combination of birth year and month, finishing and nursing pen assignments, parity, sex, and slaughter group. Additive and dominance effects were computed every 1 cM following Haley et al. (1994) interval mapping method and the estimates were obtained using least squares regression. Evidence of QTL were detected for marbling at 47 cM (P-value < .007), leanness at 90 cM (P-value < .0006), tenth rib fat thickness at 103 cM (P-value < .0004), birth weight at 104 cM (P-value < .0057), first rib fat thickness at 105 cM (P-value < .0072), average backfat thickness at 107 cM (P-value < .0013), last rib fat thickness at 108 cM (P-value < .0035), weight at 21 d at 112 cM (P-value < .0027), and tenderness at 125 cM (P-value < .0052). These results indicate that important QTL are segregating between Berkshire and Duroc breeds and this information can be used in marker-assisted selection.

Key Words: Weight, Backfat, Chromosome 6

16 Effect of heterozygosity on the incidence of bovine respiratory disease. G. D. Snowden*¹, L. D. Van Vleck², L. V. Cundiff¹, K. E. Gregory¹, and G. L. Bennett¹, ¹USDA, ARS, U.S. Meat Animal Research Center, ²USDA, ARS, MARC.

Bovine respiratory disease (BRD) is the leading cause of calf mortality. Breed differences in susceptibility to BRD are known but effect of heterozygosity is unknown. Effects of heterozygosity by breed type (B, British; C, Continental; I, *Bos indicus*) and general combining ability of 16 breeds were evaluated. Records of 71,140 purebred and crossbred calves over a 20 year period were analyzed with a single trait model using REML. Fixed effects in the model included a three factor combination (year, age of dam, and sex of calf) and calving difficulty code. Breed type heterozygosity (BB, BC, BI, CC, CI) of the calves and dams were calculated and included as 10 regression variables. Permanent environmental effect of the dam to account for repeated calving records was included. Random effects included animal and maternal genetic and maternal permanent environmental effects. The average annual incidence of BRD was 10.5%, ranging from 3.3 to 22.5%. Incidence of BRD was significantly less for all crossbred calves compared to purebred calves. Calves of BC and BI descent had less incidence of BRD than BB calves. Crosses within C or I types did not differ. Heterozygosity of dam increased BRD incidence when compared to purebred dams. Calves of CC dams had a significantly higher incidence of BRD than calves of purebred and other crossbred dams. Of the 16 breeds evaluated for general combining ability, Galloway, Red Poll, Saler, and Longhorn sired crossbred calves had the lowest BRD incidence. Limousin and Friesian crossbred calves had the highest BRD incidence. The general combining abilities of the Friesian, and Belgium Blue breeds for decreasing BRD incidence due to maternal heterozygosity were significantly better than several other breeds. Calf and maternal heterozygosity from *Bos indicus* breeds did not reduce the incidence of BRD. Reductions in incidence of BRD can result from choice of breeds to take advantages of type of combining ability.

Key Words: Cattle, Disease Resistance, Heterosis

17 Pregnancy rate in Angus heifers. J. A. Minick*, L. R. Totir, D. E. Wilson, and R. L. Fernando, *Iowa State University*.

The objective of this project was to determine the genetic control of conception rate, or pregnancy percentage in Angus beef heifers. Producers from 6 herds in 5 states provided 3144 heifer records that included breeding dates, breeding contemporary groups, service sires, and pregnancy check information. There were 214 sires represented, with 104 sires having less than five progeny, and fourteen sires having greater than fifty

progeny. These data were merged with performance and pedigree information, including actual and adjusted birth weights, weaning weights, and yearling weights, from the American Angus Association database. Heifer pregnancy rate varied from 0.75 and 0.95 between herds, and from 0.65 to 1.00 between sires, with an overall average pregnancy rate of 0.93. The software package Matvec was used to analyze the binary trait of pregnancy status at pregnancy check. This binary trait assumed an underlying continuous distribution of fertility that resulted in the threshold trait of pregnancy. A generalized linear animal model, using the relationship matrix, was fitted. This model included the fixed effects of contemporary group, age of dam, and first service sire, and the covariates of heifer age at the start of breeding, adjusted birth weight, adjusted weaning weight, and adjusted yearling weight. The relationship matrix included four generations of pedigree. The heritability of pregnancy percentage on the underlying scale was 0.13. Estimated breeding values on the underlying scale ranged from -0.4821 to 0.7993 for heifers, and from -0.5563 to 0.7038 for sires of heifers. This indicates that, while lowly heritable, some improvement in fertility could be made by selecting on heifer pregnancy rate. Possible future work includes analyzing heifer pregnancy in a multi-trait model, a Bayesian analysis of heifer pregnancy, and analysis of other female fertility traits.

Key Words: Heifer Fertility, Beef Cattle, Pregnancy

18 Genetic relationships between male and female reproductive traits in beef cattle. G. Gargantini*¹, L. V. Cundiff², D. D. Lunstra², and L. D. Van Vleck³, ¹University of Nebraska, ²RLH US Meat Animal Research Center, ³RLH US Meat Animal Research Center.

Reproductive traits were measured in 234 bulls and 1,184 heifers from matings of three dam breeds (Angus, Hereford, MARC III) with six sire breeds (Angus, Hereford, Brahman, Boran, Tuli, Belgian Blue) from the GPE Program at USMARC. Male traits were: yearling scrotal circumference (YSC), height (YH), and weight (YW), age at puberty (AP1) at production of 50 million sperm with $\geq 10\%$ progressive motility, age and scrotal circumference (AP3 and SC3) at production of 500 million sperm with $\geq 50\%$ progressive motility, and 15 mo weight (15W) and height (15H). Traits of females were age at puberty (AP, first estrus) and pregnancy diagnosis (PR) at 18 mo. The objective was to determine whether indirect selection would be effective for improving fertility traits. Estimates of heritabilities and genetic correlations between male and female traits were obtained using REML. Heritability estimates for YSC, YH, YW, AP1, AP3, SC3, 15W, 15H, AP, and PR were 0.05, 0.20, 1.00, 0.47, 0.33, 1.00, 1.00, 0.54, 0.52, 0.10. Estimates of genetic correlations between AP and YSC, YH, YW, AP1, AP3, SC3, 15W, 15H were -0.57, 0.66, 0.01, 0.16, 0.05, -0.23, -0.04, and 0.35. Estimates of genetic correlations between PR and YSC, YH, YW, AP1, AP3, SC3, 15W, 15H were 0.35, -0.48, 0.49, -0.45, -0.35, -0.97, 0.51, and 0.44. Selection of males on AP1, AP3, SC3, YH, 15W, and 15H may be useful for improving PR. Although no male trait was found to be effective for improving age at puberty in females through indirect selection, genetic correlations between AP and YSC and between AP and SC3 were favorable but small. Direct selection would seem to be more effective than indirect selection for AP in heifers. Male reproductive traits such as scrotal circumference, however, are easier and less expensive to measure than female reproductive traits and are associated with greater selection intensity.

Key Words: Fertility, Growth, Selection

19 Evaluation of Angus field records: Revisiting age of dam adjustments and genetic parameter estimates. A. Hassen*¹, D. E. Wilson, and G. H. Rouse, ¹Iowa State University.

The present study included field records of Angus progeny born during 1995 to 2002. The objective of the study was to calculate age of dam (AOD) adjustment factors and genetic parameter estimates for weaning weight (WWT) records. Eleven AOD classes were created based on age of dam at birth of progeny. To allow evaluation of regional differences on AOD effect, the US was divided into nine regions based on general climatic conditions, management, as well as topographic features. Data were analyzed separately for bull and heifer calves. Initially, data were analyzed by region using a model that included fixed effects of contemporary group, AOD-management class, random effects of direct genetic, maternal genetic, permanent environment, and residual effects.

In further analysis, data were pooled across regions and sub-samples were analyzed using a similar model. Regardless of region, AOD effects showed a similar trend in which WWT of progeny increased with AOD, plateaued at about 6 to 8 years of age, followed by a decline for the rest of AOD groups. Results from data pooled across region often showed a similar effect of AOD classes for both creep and non-creep fed bulls and heifers. Minor AOD effect differences observed for the older AOD group were due to small sample sizes for creep fed progeny and were therefore associated with relatively large standard error of estimates. Heritability of WWT for bulls and heifers averaged at 0.31 and 0.38, respectively. For both sexes, the covariances between direct and maternal genetic effects were different from zero ($P < .01$). Mean genetic correlation between direct and maternal genetic effects was -0.59. Further study is needed to evaluate the possible use of continuous AOD adjustment factors based on regression procedures. In addition, effects of using negative covariance between direct and maternal genetic effects on sire rankings and genetic trends should be studied before attempts to use these values in the national cattle evaluation programs for the American Angus association.

Key Words: Beef cattle, Age of Dam, Weaning Weight

20 Heritability estimates for carcass traits adjusted to an age, weight or fat constant basis. A. Ríos-Utrera^{*1}, L. V. Cundiff², K. E. Gregory², and L. D. Van Vleck³, ¹University of Nebraska, ²RLH US Meat Animal Research Center, ³RLH US Meat Animal Research Center.

Carcass measurements of 1,664 steers (serially slaughtered) from 12 breed groups (Red Poll, Hereford, Angus, Limousin, Braunvieh, Pinzgauer, Gelbvieh, Simmental, Charolais, MARC I, MARC II, and MARC III) from the GPU Program at USMARC were used to estimate heritabilities for carcass traits adjusted to different end points. Traits were hot carcass weight (CW), dressing percentage (DP), adjusted fat thickness (FT), ribeye area (RA), kidney-pelvic-heart fat percentage (KF), marbling score (MS), yield grade (YG), estimated retail product (ER), retail product weight (RW), fat weight (FW), bone weight (BW), retail product percent (RP), fat percent (FP), and bone percent (BP). The model included breed group, feed level, age of dam, year of birth, their significant interactions, days on feed, end point nested within breed group, additive genetic effect of the animal, and total maternal effect of the dam. Heritabilities were estimated by REML. Estimates of heritabilities for CW, DP, FT, RA, KF, MS, YG, ER, RW, FW, BW, RP, FP, and BP at constant age, weight, and fat thickness, respectively, were 0.27, -, and 0.41; 0.19, 0.26 and 0.18; 0.20, 0.21, and -; 0.24, 0.25 and 0.25; 0.23, 0.23 and 0.26; 0.40, 0.41 and 0.35; 0.30, 0.30 and 0.24; 0.30, 0.30 and 0.24; 0.42, 0.32 and 0.50; 0.28, 0.35 and 0.29; 0.43, 0.32 and 0.48; 0.42, 0.44 and 0.41; 0.31, 0.35 and 0.26; and 0.28, 0.33 and 0.35. Standard errors for estimates of heritability ranged from 0.071 to 0.095. Phenotypic variances changed with different end points. In general, estimates of heritability and phenotypic variance for carcass traits on age, weight or fat constant basis indicate that enough genetic variation exists to change carcass merit by selection. However, for some carcass traits the magnitude of change will depend on the effect of slaughter end point on heritability and phenotypic variance.

Key Words: Beef Cattle, Carcass Traits, Heritability

21 Feed efficiency of F1 cross steers by British and Continental European sire breeds. L. V. Cundiff*, T. L. Wheeler, S. D. Shackelford, and M. Koohmaraie, USDA, ARS, U.S. Meat Animal Research Center.

The objective was to characterize F1 cross steers for efficiency of post weaning live weight gain (g/Mcal ME) in time (TIME = 0 to 187 d) and weight (WT = 340 to 590 kg) intervals or from the starting date (day 0) to a marbling (MARB = small degree of marbling), fat thickness (FTH = 1.1 cm), fat trim (FTR = 24.8% fat trim), or weight of retail product (RP = 225 kg) endpoint. Data were obtained on 649 steers born in 1999 and 2000 resulting from matings of Hereford, Angus, and composite MARC III (1/4 each Angus, Hereford, Red Poll, and Pinzgauer) cows to sires of three British breeds (B: Hereford, 21 sires; Angus, 22; and Red Angus, 21) and four Continental European breeds (C: Simmental, 20; Gelbvieh, 23; Limousin, 20; and Charolais, 22). The steers were weaned in mid-October at a mean age of 202 d. Following a 30 d conditioning period, the steers were assigned to replicated pens (2 pens per sire breed

per yr). Feed consumption was recorded daily. Steers were fed a growing diet (2.62 Mcal ME/kg DM) until early February (about 320 kg) and a finishing diet (3.05 Mcal ME/kg DM) until slaughter. Steers were slaughtered in 5 groups spanning 43 d the first yr and 4 groups spanning 53 d the second yr. Retail product (boneless - totally trimmed, .0 cm outside fat) and fat trim were estimated using wholesale rib dissection prediction equations. Regression of MARB, FTH, FTR and RP on days on feed was used to estimate days required for each sire breed to reach each endpoint. Quadratic regression of pen mean weights and cumulative ME on days fed were used to estimate pen mean efficiencies for each interval and endpoint. Effects of sire breed were not significant for efficiency in TIME or WT constant intervals. Steers with B sires were more efficient ($P < .01$) than those with C sires to MARB (B = 59.9, C = 54.7, g/Mcal), FTH (B = 59.3, C = 54.5), and FTR (B = 59.6, C = 54.7) endpoints. However to the RP endpoint, steers with C sires (58.3) were more efficient ($P < .01$) than those with B sires (54.9).

Key Words: Cattle, Breeds, Feed Efficiency

22 Genetic trends for litter weight weaned per ewe lambing for two lines of Rambouillet sheep divergently selected for litter size. J.M. Rumph^{*1}, K.C. Davis¹, and P.J. Burfening², ¹Montana State University, ²USDA, CSREES.

Genetic parameters and genetic trends for litter weight weaned were estimated using 10,352 lambing records and 9,098 weaning records on 2,483 ewes from two selection lines of Rambouillet sheep at Montana State University in Bozeman, Montana. The lines have been divergently selected for increased (HIGH) and decreased (LOW) litter size since 1970 and are currently at more than one lamb per ewe difference between the two lines. Rams were used only as yearlings and had the highest (or lowest) breeding values per sire group. Ewes were selected based only on breeding value so that approximately 30 replacements per line were kept each year regardless of sire group. After weaning at six years of age (opportunity to produce lambs for five years), ewes were culled. Ewes had to have a least one lamb born within a year in order to be included in the data set for that year. The model included fixed effects of year of birth, age of ewe, and line. Linear and quadratic covariates of julian birth date and age at weaning were also included. Random effects included direct genetic, maternal genetic, direct-maternal genetic correlation, uncorrelated direct permanent environment, and residual. Estimates of genetic parameters (and associated standard errors) were 0.07 (0.02), 0.01 (0.01), 0.22 (0.81), and 0.02 (0.02) for direct heritability, maternal heritability, direct-maternal correlation, and proportion of variance attributed to direct permanent environmental effects, respectively. Trends for average direct breeding value per year of birth for litter weight weaned per ewe lambing through 2003 were 0.12 kg/yr and -0.03 kg/yr for HIGH and LOW, respectively. For maternal breeding values, trends were 0.016 kg/yr and -0.003 kg/yr for HIGH and LOW, respectively. Selection for increased or decreased litter size will have the same effect on litter weight weaned.

Key Words: Litter Size, Selection, Weaning Weight

23 Evaluation of an autoregressive repeatability animal model for analysis of first lactation test day records of Holstein cows. R. M. Sawalha^{*1}, J. F. Keown¹, S. D. Kachman², and L. D. Van Vleck³, ¹Department of Animal Sciences, University of Nebraska, ²Department of Statistics, University of Nebraska, ³USDA, ARS, USMARC.

Three models were compared: Model 1 had a first order autoregressive covariance structure among test day environmental components, Model 2 was a repeatability animal model using test day records, and Model 3 was an animal model using 305-day records. Data on 12,071 first lactations of Holstein cows with a total of 106,472 TD records were available on milk, fat, and protein yields and somatic cell scores (SCS). Estimates of genetic and environmental components of variance and autocorrelation coefficients were obtained with the ASReml program using average information algorithm. Likelihood ratio tests indicated that Model 1 was significantly better than Model 2 for all four traits. Model 1 had slightly lower estimates of heritability than Model 2 ranging from 0.08 to 0.10 for yield traits and 0.06 for SCS. Model 3 resulted in estimates of heritability ranging from 0.13 to 0.36. Similarly, estimates of repeatabilities and variance components associated with permanent environmental

effects were always less for Model 1 than for Model 2. Removing permanent environmental effects from Model 1 resulted in inflated estimates of genetic variance and thereby biased estimates of heritability. The lowest rank correlations of predicted breeding values (PBV) of sires and cows were between those for Model 3 and Models 1 and 2 (0.71 to 0.87) for all traits. Correlations between PBV with Model 1 and Model 2 were always greater than 0.99 for both sires and cows for all traits. Of the top ten elite sires for milk yield, nine were common between Models 1 and 2, six between Models 1 and 3 and five between model 2 and 3 with similar patterns for the other traits. Both Model 1 and Model 2 resulted in similar accuracies of PBV for all traits with accuracies for sires almost twice those for cows. The autoregression covariance structure helped prevent overestimation of heritability and repeatability for all four traits.

Key Words: Genetic Evaluation, Milk Yield, Test Day

24 Modification of MTDFREML to estimate variance due to genetic competition effects. L. D. Van Vleck*¹ and J. P. Cassady², ¹RLH US Meat Animal Research Center, ²North Carolina State University.

Muir recently proposed a selection model that contains genetic competition (called "associative" by Muir) effects for animals in the same pen as well as the direct genetic effects of the animals with records. The competition effect for one animal will be expressed in records of all pen mates. A competition effect is a "second" animal genetic effect similar to a maternal genetic effect. Differences from a model with maternal effects are: 1) a record may be influenced by several second animal effects rather than one, and 2) animals contributing competition effects may not be related or related to the animal with a record. The modification needed for the MTDREML programs to allow estimation of variance due to competition effects and covariance between direct and competition genetic effects was to change MTDPREP to allow a vector of second animal genetic effects, rather than one second animal effect, to be associated with the record of an animal. At least one competitor is needed. The numerator relationship matrix accounts for additive relationships among competitors, which allows partition of variance due to genetic direct and competition effects. Calculation of fractions of total variance such as heritability is more difficult because the phenotypic variance cannot be computed in general. The portion of phenotypic variance due to genetic competition effects will depend on number of competitors and on numerator relationships among competitors in the group of competitors. Estimates of (co) variance components and not fractions of total variance, however, are what is needed for genetic evaluation and selection. Some concerns are: 1) whether variances due to competition effects are the same for all physical dimensions of pens, 2) whether number of pen mates will affect variances, and 3) whether outliers will affect estimates of variance due to competition effects.

Key Words: Behavior, Breeding Values, Competition

25 Estimation of (co) variance components due to genetic competition effects in pigs. J. P. Cassady*¹ and L. D. Van Vleck², ¹North Carolina State University, ²USDA-ARS, Roman L. Hruska U.S. Meat Animal Research Center.

The objective of this project was to estimate (co) variance components for direct and competition genetic effects in pigs. Public pressure is increasing on American pig producers to consider animal well-being. Significant efforts have been placed on modifying facilities and production practices to create a better environment for pigs. However, relatively little consideration has been given to adapting pigs themselves. If heritable measures of pig behavior can be identified, pig behavior might be modified genetically to benefit both pigs and producers. Pigs (n = 410) in this experiment were a cross between a Duroc-Hampshire composite line selected for decreased days to 105 kg (DAYS) and backfat and a Landrace-Large White line selected for increased litter size. At 76 ± 6 d of age, pigs were penned in groups of eight by sex. Area of each pen was 7.4 square meters. A restriction was that full-sibs were not penned together. Traits recorded were on test weight (IWT), ADG, DAYS, and backfat adjusted to 105 kg (ABF). Analyses were with a version of the MTDFREML program, which was modified to allow for a vector of second animal genetic effects. Pen mates were considered to be competitors and were entered as second animal effects. Thus, each pig had effects of seven competitors included in its record. Estimates of

heritabilities of direct effects were 0.57, 0.63 and 0.28 for DAYS, ADG, and ABF, respectively. Estimates of heritabilities of competition effects were 0.01, 0.02, and 0.00 for DAYS, ADG, and ABF, respectively. Although heritability of competition effects appears to be very low in this experiment, estimation of these (co) variance components in larger experiments with pigs of different genetic backgrounds and under different pen environments may be of interest. How competition effects should be included in selection indices is important to consider as would rankings of potential breeding animals with and without considering genetic competition effects.

Key Words: Behavior, Competition, Heritability

26 Comparison of growth patterns for loin muscle area, backfat, and intramuscular fat percentage between pigs sired by boars from two different time periods. C. R. Schwab*, T. J. Baas, D. W. Newcom, and K. J. Stalder, Dept. of Animal Science, Iowa State University.

Serial ultrasonic measurements of 10th rib loin muscle area (LMA), off-midline backfat (BF), and intramuscular fat percentage (IMF) were used to assess deposition rates and growth patterns of purebred Duroc pigs sired by boars currently available and by boars from the mid 1980's. Two lines were formed by randomly allocating littermate and ½ sib pairs of females to matings by current (CTP) or old (OTP) time period boars. Matings by CTP boars were made using fresh semen and matings by OTP boars were via frozen semen. A total of 298 pigs by 16 sires in the CTP line and 124 pigs by 10 sires in the OTP line were evaluated. Boars, gilts, and barrows in each line were weighed and scanned for LMA, BF, and IMF every two weeks beginning at a group mean live weight (LW) of 63.5 kg. Off test ultrasonic measurements were taken at approximately 109 kg. Deposition rates were calculated for dependent scan variables (LMA, BF, and IMF) using intra-pig linear and quadratic regressions for the independent variable live weight. Intra-pig linear and quadratic regression coefficients and y-intercepts were analyzed as dependent variables in a mixed model that included fixed effects of line, sex, contemporary group, and the interaction of sex by line. Sire and dam nested within line were included as random effects. Mean deposition rates for LMA, BF, and IMF were not significantly different between the two lines. Pigs sired by CTP boars had more LMA (P<.05) than those sired by OTP boars at scan 1 (24.70 cm² vs. 22.90 cm²), scan 3 (32.12 cm² vs. 28.64 cm²), and scan 5 (38.96 cm² vs. 33.60 cm²). Likewise, CTP pigs had less backfat (P<.05) than OTP pigs at scan 1 (13.21 mm vs. 14.99 mm), scan 3 (16.51 mm vs. 19.81 mm), and scan 5 (18.54 mm vs. 23.88 mm). Time period differences for ultrasonically measured IMF percentage were not significant at scan 1; however, pigs sired by CTP boars deposited less IMF (P<.05) than pigs sired by OTP boars at scan 3 (3.55 % vs. 3.96 %), and scan 5 (3.99 % vs. 4.51 %).

Key Words: Swine, Ultrasound, Regression

27 Relationship between backfat depth and its individual layers and intramuscular fat percentage in swine. D. W. Newcom*, T. J. Baas, and K. J. Stalder, Dept. of Animal Science, Iowa State University.

Cross-sectional ultrasound images were collected at the 10th rib from purebred Duroc barrows (n = 284) and gilts (n = 46) from the Bilstrand Memorial Swine Breeding Farm at Iowa State University 5 d prior to harvest to estimate genetic parameters and relationships among components of backfat depth and intramuscular fat. Off-midline total backfat (SBF) and loin muscle area (SLMA) were measured. Individual subcutaneous backfat layers were measured in the same location as total backfat: outer (O), middle (M), and inner (I). Off-midline backfat (CBF) and loin muscle area (SLMA) were measured on the carcass 24 h post-mortem. A slice from the 10th rib of the loin muscle was obtained for intramuscular fat percentage determination (IMF). A mixed linear model with fixed effects of sex and contemporary group, off-test weight as a covariate, and a random sire effect was used to estimate heritability from the sire variance component. A multiple-trait fixed linear model with fixed effects of sex and contemporary group was used to estimate residual correlations. Heritability estimates for the outer, middle, and inner backfat layers were 0.30, 0.40, and 0.70, respectively. Heritability estimates for SBF, CBF, SLMA, and CLMA were 0.42, 0.54, 0.19, and 0.36, respectively. Heritability for IMF was estimated as 0.65. Residual correlations between IMF and CBF, SBF, O, M, and I were 0.29, 0.27,

0.23, 0.21, and 0.27, respectively. Residual correlations between O and M, O and I, and M and I were 0.61, 0.38, and 0.62, respectively. Results show the correlations between IMF and different measures of fat thickness are of similar magnitude, regardless of the measure being a total or individual layers. Results also show that the correlation between the inner and outer backfat layers is less than the correlation between the middle layer and the inner and outer layers.

Key Words: Swine, Backfat Layers, Intramuscular Fat Percentage

28 Differences of triacylglycerol and phospholipid content of pork *longissimus dorsi* by breed, gender, and halothane genotype. T. J. Knight¹, K. J. Stalder¹, D. C. Beitz¹, R. N. Goodwin², and S. M. Lonergan¹, ¹Iowa State University, ²National Pork Board.

The objective of this study was to determine the breed, sex, and halothane genotype effect on the amount of phospholipid, triacylglycerol, and total lipid in LD of market pigs. Pigs (n=769) from the 1994 and 2001 National Barrow Show Sire Progeny Tests were used in this study. The test included purebred Berkshire (86), Chester White (76), Duroc (140), Hampshire (53), Landrace (86), Poland China (53), Spotted (40), and Yorkshire (140) barrows (453) and gilts (316). These pigs were from 100 sires and 367 dams. The halothane (Hal 1843TM) genotype was determined by DNA typing as outlined by Fujii et al. (1991). Diets were uniform within test and across breeds. Pigs were slaughtered at 105 kg body weight and samples of the LD were obtained from each carcass at the 10th rib. Data were analyzed using a mixed linear model including test, gender, halothane genotype, breed, and breed by sex interaction as fixed effects, with sire and dam within breed included as random effects. There were breed and sex effects ($P < 0.05$) for total lipid concentration in the LD, with barrows and gilts averaging 2.88 and 2.21 g lipid per 100 grams meat, respectively. The Yorkshire, Hampshire, Landrace, and Spotted breeds had the least amount of total lipid (g/100 g tissue) and were not significantly different from each other. The Duroc and Berkshire breeds had the greatest total lipid and were not different from each other. There were no breed or sex effects for phospholipid, however, the triacylglycerol statistics nearly mirrored the patterns observed for total lipid data. Therefore, statistical differences noted in total lipid are explained by differing amount of triacylglycerol and not differing amount of phospholipid. There were no differences noted for halothane genotype with respect to amount of total lipid, phospholipid, or triacylglycerol. In conclusion, as total lipid increases, triacylglycerol increases while phospholipid remains constant.

Key Words: Pigs, Genetics, Lipids

29 Biological responses of pigs from two populations of PRRSV challenge. D. B. Petry*, J. W. Holl, F. A. Osario, A. R. Doster, J. S. Weber, and R. K. Johnson, *University of Nebraska*.

One hundred pigs from the NE Index Line, I, and 100 Duroc-Hampshire cross pigs, HD, were infected intra-nasally with Porcine Respiratory and Reproductive Syndrome virus (PRRSV RFLP-Iowa Strain) at 26 d of age to determine whether genetic variation in responses to PRRSV exists. An unchallenged littermate to each pig served as a control. Pigs were from 163 dams and 83 sires. Body weight and temperature were recorded and blood samples were drawn from each pig on d0, d4, d7, and d14 post-challenge. Pigs were sacrificed on d14 and lung and lymph nodes were collected. Serum samples, lung and lymph were analyzed for presence of PRRSV. Presence of antibodies in serum samples taken at d14 was determined by the ratio of levels in the sample to levels in positive controls. Lung tissue was observed microscopically and scored for incidence and severity of lesions (score of 0 to 3, 0=no lesions, 3=severe incidence). Data were analyzed with a mixed model that included random sire and dam effects. Interaction of line by challenge (PRRSV negative vs. PRRSV positive) was significant for weight gain and body temperature. Unchallenged HD pigs gained 0.50 kg more from d0 to d14 and averaged 0.32deg C higher temperature than I pigs ($P < 0.0001$). I pigs infected with PRRSV gained 0.75 kg more and had -0.54deg C lower temperature than infected HD pigs ($P < 0.0001$). Serum viremia, \log_{10} of number of colonies per dl of serum, was greater ($P < 0.05$) in HD than I at d4 (4.52 vs. 4.23), d7 (4.47 vs. 3.99), and d14 (3.49 vs. 3.23). HD pigs had higher viremia in lung ($P = 0.11$) and lymph ($P = 0.07$) than I pigs. Antibody ratios in challenged pigs ranged from 0.18 to 3.38, 88% had levels ≥ 0.40 , the level considered as positive for

PRRSV. The range in unchallenged pigs was 0 to 1.11, 99% had levels ≤ 0.40 . Mean ratio of challenged pigs was 0.23 units higher in HD than in I ($P = 0.0009$). HD pigs had greater incidence of interstitial pneumonia and 0.57 higher mean lesion scores than I pigs ($P < 0.0001$). Response of pigs of the two lines to PRRSV challenge differed indicating underlying genetic variation exists.

Key Words: Virus, Genetic Variation, Biological Indicators

30 Behavioral and biological assessment of animal well-being and welfare in cattle. B. Earley*, *Teagasc, Grange Research Centre, Ireland*.

The welfare of farm animals is of increasing importance both for the general public and for the scientific community. Cattle subjected to routine husbandry stressors such as castration, weaning, and transport have heightened susceptibility to many production diseases, especially the respiratory disease complex. Scientific evidence supports a general link between stress and disease susceptibility. Despite the fact that clear molecular links between stress and immunity are not well defined, the economic impact of stress-induced disease susceptibility is immense. The behavioral and physiological responses of animals to stressors are largely mediated through the central and peripheral neuroendocrine pathways, culminating in profound alterations in the trafficking and function of blood leukocytes and in blood hormone profiles. Blood cortisol concentrations peak ($P \leq 0.001$) by 2 hours post stressor in our experimental models of inflammation (surgical castration), anxiety stress (abrupt weaning), and severe environmental insult (transportation stress). Stress-induced changes in the numbers of various leukocyte subsets (increase ($P \leq 0.01$) in neutrophils and decrease ($P \leq 0.01$) in lymphocytes), their migration from blood and subsequent function in secondary lymphoid and peripheral tissue sites of infection, are the main factors influencing spread of infection and disease susceptibility in animals. Mechanistically, cortisol influences the expression of multiple genes and thus the phenotype of target tissues that co-ordinate the body's response to stress. Unravelling the interactions between behavior, stress hormones and resulting changes in circulating immune cells is currently one of the greatest challenges in the biology of stressed animals.

Key Words: Welfare, Stress, Immunity

31 Physiological aspects of genetic selection in farm animals. Heng-wei Cheng*, *Livestock Behavior Research Unit, USDA-ARS*.

An animal consists of an integration of multiple biological organs and systems. Selection based on one character affects the function of other systems, such as modifying the physiological homeostasis and behaviors, which results in changes in the heritable properties of the animal. Group selection, an alternative method to traditional breeding programs, allows selection on production traits but takes into account competitive interactions by which anti-social behaviors are overcome. Using this program, two lines of White Leghorn chickens were diversely selected for high (HGPS) or low (LGPS) group productivity and survivability resulting from changes in cannibalism and flightiness in colony cages. Genetic variation in physiological responses to stress has been identified in the selected lines. Compared to the HGPS line, LGPS line had greater blood concentrations of dopamine and epinephrine. Blood concentrations of norepinephrine were not significantly different between the lines but the ratio of epinephrine to norepinephrine was greater in LGPS line ($P < .05$). The blood concentrations of serotonin were also greater in LGPS line compared to HGPS line ($P < .05$, Cheng et al., 2001). In addition, the LGPS line exhibited eosinophilia and heterophilia and had a greater heterophil:lymphocyte ratio, whereas the HGPS line displayed a greater cell-mediated immunity with a higher ratio of CD4:CD8 (Cheng et al., 2001). The results indicate that selection has altered chickens physiological homeostasis that produces the lines unique coping ability with various social stressors (Hester et al., 1996; Cheng et al., 2002). The data further suggest that an efficient breeding program should focus on a trait that includes alterations of physiological functions under a constant selection pressure such as productivity. The group selection program has great practical implications to improve

animals livability, productivity, and welfare, and the alterations of physiological parameters can be used as indicators in the evaluation of the efficiency of a breeding program and its relation to animal well-being.

Key Words: Genetic Selection, Physiology, chickens

32 Impact of stressors on disease resistance of different genotypes. J. Welsh*, W. Mi, R. Johnson, A. Steelman, A. Sieve, C. Young, R. Storts, T. Welsh*, and M. Meagher, *Texas A&M University*.

Psychological stress has profound effects on, hypertension, coronary heart disease, cancer, obesity, diabetes, depression, infectious and autoimmune diseases. These effects are mediated by interactions between the endocrine, immune and nervous systems. Restraint stress increases mortality and susceptibility to Theilers virus-induced demyelination (TVID) (a mouse model of multiple sclerosis) in genetically susceptible strains of mice. In this model, stress activates the hypothalamic pituitary-adrenal axis and the autonomic nervous system which results in immunosuppression mainly through the increased production of glucocorticoids. Stressed mice have decreased NK cell activity and decreased inflammatory cell infiltrates into the brain which may account for increased viral replication and mortality. Alterations in the immune system have been shown to render strains of mice that are genetically resistant to TVID, susceptible to the disease. However, restraint stress does not alter susceptibility to the disease in TVID-resistant mice. Therefore, although restraint stress increases disease severity in TVID-susceptible strains of mice, it is unable to overcome the genetic resistance to this disease in TVID-resistant mice. This research was funded by grants to C.J.R.W. and M.W.M. from the National Multiple Sclerosis Society RG 3128 and NIH/NINDS R01 39569.

33 Breeding opportunities for animal welfare improvement. K. H. de Greef*¹ and E. Kanis^{1,2}, ¹*Animal Sciences Group, Lelystad, Wageningen-UR*, ²*Wageningen University*.

There are ample breeding opportunities for improvement of animal welfare. Application is not only hindered by the lack of well defined and easy to measure traits but also by the public sensitivity for both the welfare issue and for breeding as such. In North-west Europe, offering housing conditions that meet the needs of the animals is generally regarded as the principal means to elevate farm animal welfare levels. Applying breeding techniques to raise welfare levels is delicate, as animal breeding is often blamed for having caused welfare infringements. Also, there is public worry about changing animal populations away from their natural characteristics.

Key factors that cause animal welfare infringements on farm are husbandry conditions that fail to meet the behavioural needs, aggressive pen mates, unfavourable side effects of high productivity and, last but not least, disease. A straightforward evaluation reveals that genetic selection aiming at changing behavioural patterns is the most ethology-related welfare measure, but socially controversial. Breeding for disease resistance is a clear win-win opportunity but is generally far from practically feasible. Correction and prevention of undesirable side effects of productivity is a breeding aim that cannot be neglected from a corporate social responsibility point of view.

As a demonstration of opportunities to breed for better welfare in a refined way, a conceptual model that describes animal comfort as a function of environmental conditions (space, ambient temperature, etc.) will be presented. It demonstrates the close connection and considerable interaction between animal and environment. It provides behavioural traits that are expressed in environmental units (degC, m² etc.). From this model, two animal characteristics (tolerance and adaptation capacity) appear that provide opportunities to include behavioural characteristics in breeding programs. Enhancing the animals' abilities to cope with their environment is a conceptually and socially attractive approach. It explicitly meets the public call for more robust animals.

Key Words: Animal Welfare, Genetic Improvement, Modeling G*E

34 Linkage disequilibrium measures between markers as predictors of linkage disequilibrium between markers and QTL. H. Zhao*¹, D. Nettleton¹, M. Soller², and J. C. M. Dekkers¹, ¹*Iowa State University*, ²*Hebrew University of Jerusalem, Israel*.

Effectiveness of marker-assisted selection using population-wide linkage disequilibrium (LD) depends on the extent of marker-to-QTL (M-Q)

LD. To evaluate alternative measures of observable (marker-to-marker) LD as predictors of M-Q LD, LD among 4-allele markers and a biallelic QTL was simulated by 100 generations of random mating of 100 parents. Using 100 individuals in generation 100, M-Q LD was quantified by the R² of regression of QTL allele on alleles at a single marker. Observable LD was evaluated using: Lewontins D' r²=pooled square of correlations between alleles weighted by the product of allele frequencies; χ^2 =Chi-square statistic for association between alleles; and a standardized $\chi^{2'}=\chi^2/[N(n-1)]$, where N=number of haplotypes and n=smallest number of alleles across the 2 markers. Extensive M-Q LD existed at short distances but declined rapidly with distance. Observable LD showed similar declines for r², χ^2 and $\chi^{2'}$, but D' was strongly inflated. Correlations of mean D', r², χ^2 and $\chi^{2'}$ between markers with mean M-Q LD at corresponding distances (≤ 20 cM) were 0.85, 0.96, 0.96 and 0.96. Correlations of means for different population sizes (10 200) of D', r², χ^2 and $\chi^{2'}$ at 2cM with means of M-Q LD at 1cM were 0.80, 0.80, -0.66 and 0.75. Corresponding correlations for means at different generations (0 200; population size of 100) were 0.56, 0.70, 0.33 and 0.74. Although r² and $\chi^{2'}$ both correlated well with M-Q LD, $\chi^{2'}$ is preferred because it ranges from 0 to 1, while r²<1 for multi-allelic markers in complete LD. To assess the decline in LD with distance, LD_d=1/(1+4 β d) was fitted to data on 100 individuals in generation 100 where d is distance in Morgans, and β is related to effective population size. Estimates for β were 51.4 and 63.8 for $\chi^{2'}$ and M-Q LD, resulting in very similar lines. In conclusion, $\chi^{2'}$ is a good predictor of LD between markers and QTL when LD is generated by drift alone.

Key Words: LD, QTL

35 Optimal haplotype structure for linkage disequilibrium-based fine mapping of quantitative trait loci. L. Grapes*¹, M. Z. Firat^{1,2}, J. C. M. Dekkers¹, M. F. Rothschild¹, and R. L. Fernando¹, ¹*Iowa State University*, ²*Akdeniz University*.

In a previous study of linkage disequilibrium-based methods for fine mapping quantitative trait loci (QTL) using either haplotype or single marker information, it was found that fitting a haplotype consisting of all available markers did not result in the highest mapping accuracy. The haplotype information was used to determine if individuals' QTL alleles were identical by descent (IBD) in order to model their covariance. In this study, haplotypes of one, two, four, six and all ten available markers were used for fine mapping in multiple simulated populations to determine if an optimal haplotype structure exists for the IBD-based method. In nearly all cases, using a haplotype of four or six markers resulted in the highest mapping accuracy ($p < 0.05$). In all cases, fitting a haplotype of one marker resulted in the lowest mapping accuracy ($p < 0.05$). By examining characteristics of the IBD-based method, it was found that marker information must allow sensitivity to the putative QTL position while providing sufficient power to detect the QTL. Of the haplotype structures tested, a four-marker haplotype best accomplishes this. Thus, in populations similar to those used here, an optimal haplotype structure does exist for the IBD-based method. Future QTL fine mapping studies that utilize the IBD-based method should consider fitting a smaller number of markers as the haplotype and using the information as a sliding "window" across the chromosomal region.

Key Words: Fine Mapping, Linkage Disequilibrium, Quantitative Trait Loci

36 A strategy to improve the computational efficiency of mapping quantitative trait loci by the identity by descent method. M. Z. Firat*^{1,2}, F. V. C. Pita³, H. Gilbert^{1,4}, L. R. Totir¹, R. L. Fernando¹, and J. C.M. Dekkers¹, ¹*Department of Animal Science, Iowa State University*, ²*Akdeniz University, Faculty of Agriculture, Department of Animal Science, Turkey*, ³*Department of Animal Science, Federal University of Vicosa, Brazil*, ⁴*Station de Genetique Quantitative et Appliquee, Institut National de la Recherche Agronomique, France*.

In identity by descent (IBD) methods to map QTL, the likelihood is a function of IBD probabilities at the putative position of the QTL conditional on observed marker and pedigree information. When marker information is incomplete, exact computation of IBD probabilities is difficult, but they can be estimated by sampling QTL genotypes conditional on the observed information using MCMC methods. This sampling process has to be repeated at each putative position of the QTL, which is

computationally demanding. Here we propose to use MCMC to estimate the joint distribution for the segregation indicators of markers flanking each chromosomal segment and to approximate IBD probabilities at positions within the segment based on this joint distribution without additional sampling. Using this approach, the Newton-Raphson algorithm can be used to efficiently estimate the QTL position and variance components for the QTL, polygenic effects, and for residuals. First and second derivatives of the residual likelihood required for the Newton-Raphson algorithm are obtained by an automatic differentiation procedure. The likelihood is maximized with respect to a set of transformed parameters for which the parameter space is restricted. The accuracy of this method needs to be evaluated.

Key Words: Quantitative Trait Loci, Identity by Descent, Newton Raphson Algorithm

37 An efficient algorithm to compute genotype probabilities for every member of a pedigree with loops. L. R. Totir^{*1}, R. L. Fernando¹, and B. Gulbrandsen², ¹Iowa State University, ²Danish Institute of Animal Science.

Genotype probabilities are needed for many genetic analyses ranging from QTL mapping to marker assisted selection. As shown below, genotype probabilities can be calculated from likelihood calculations. The likelihood of an arbitrary pedigree can be written as: $L = \sum_{G_1} \dots \sum_{G_n} f_1(s_1) \dots f_n(s_n)$, where G_k is the genotype of individual k , s_k is a set of individuals, and f_k is the product of either a founder or a transmission probability with the penetrance function of individual k . Computing L by peeling involves summing over the genotypes of one individual at a time. This summation for G_k is done conditional on all possible values of the other genotypes that occur together with G_k in any of the factors of L . The result of the summation is stored in a multidimensional table, F_k , called a cutset. This cutset replaces in L all the factors that contributed to F_k . Continuing this process for all the individuals yields L . Let $L(G)$ be the likelihood computed with G_k fixed at G . Then, the probability $P(G_k=G) = L(G)/L$. Using this procedure, to compute probabilities for x unknown genotypes of an individual would require recomputing the likelihood for the entire pedigree x times. Note, however, that fixing G_k at G will have no effect on the values stored in any F_j for $j < k$ in the peeling sequence. Thus, these F_j need not be recalculated for different values of G_k . This idea can be extended by introducing another multidimensional table B_k such that $L = \sum_{S_k} F_k B_k$, where the summation is over the genotypes that were conditioned on in computing F_k . Note that $\sum_{S_n} F_n = L = \sum_{S_n} F_n B_n$, and thus $B_n = 1$. Using these relationships, once $F_1 \dots F_n$ are available, all B_k can be computed starting with B_n and proceeding in the reverse order of peeling. It can be shown that fixing G_k at G will have no effect on the values stored in any B_k for $j > k$ in the peeling sequence. Now, genotype probabilities can be computed using $L = \sum_{S_k} F_k B_k$, without repeated computations of either F_k or B_k .

Key Words: Likelihood, Peeling

38 The Jerusalem resource population: a multi-generation quasi-full-sib intercross population for high power and high resolution QTL mapping in poultry; initial QTL mapping results. EM Heifetz^{*1,4}, H Khatib^{1,2}, A Nave¹, D Heller³, Y Eitan¹, JCM Dekkers⁴, and M Soller¹, ¹Dept. of Genetics, The Hebrew University of Jerusalem, Israel, ²Dairy Science Dept., University of Wisconsin, ³Dept. of Animal Science, Faculty of Agriculture, Israel, ⁴Dept. of Animal Science, Iowa State University.

The Jerusalem Resource Population, now at F18, was constructed by crossing a single White Rock heavy breed male with five semi-inbred Leghorn layer females. The population was phenotyped in each generation for growth rate, anatomical and egg production traits, and in some generations for immune response. The population did not show any obvious effects of inbreeding, and phenotypic variation, heritabilities and genetic correlations were similar to those found for normal populations. The present study reports results of genotyping 100 to 400 individuals from the F2-F4 generations with respect to a battery of 23 microsatellite markers, randomly chosen. Population-wise associations of each marker with each trait were tested at the marker level by single marker ANOVA, and at the allele level by allele substitution tests. At the marker level 23.2% of P-values were less than 0.10; the corresponding value at the allele level was 17.3%. There was a close correspondence between combinations significant at the marker and allele levels. Critical P-values

for 20% False Discovery Rate (FDR) were 0.020 at the marker level, and 0.0145 at the allele level. At these levels, 28 out of 276 marker by trait combinations, and 30 out of 492 allele by trait combinations were significant. Most of the significant effects were with respect to body weight and composition (breast weight (BrW); %BrW; abdominal fat pad weight (AW); %AW; shank length (SL) and relative SL). No significant associations were found with immune response, and very few associations with female reproduction traits. These results strongly support the presence of marker-QTL linkage in this population. Hence, this design, and specifically this population provide a powerful method for QTL mapping.

Key Words: QTL Mapping, FSIL, Association Test

39 Detection of QTL for meat quality in an F2 cross in swine using combined line-cross and half-sib analysis. J.-J. Kim^{*}, H.-H. Zhao, H. Thomsen, M. F. Rothschild, and J. C. M. Dekkers, Iowa State University.

Data from an F2 cross between outbred breeds of livestock is typically analyzed using a line-cross (LC) model to detect QTL that differ between breeds. Alternatively, data can be analyzed using a half-sib (HS) model for F1 sires to allow for QTL that segregate within breeds. In this study, these two approaches were combined to increase the power to detect QTL and to identify QTL that segregate within breeds for a total of 40 growth, carcass, and meat quality traits in a Berkshire (2 boars) x Yorkshire (9 sows) cross with eight F1 sires and 510 F2 progeny. Least squares regression interval mapping was used to detect QTL at the 5% chromosome-wise (CW) level using the standard LC and HS models and a combined (COMB) model. The latter consisted of additive and dominance breed-origin coefficients from the LC model, along with within-F1-sire substitution effects from the HS model. Within-breed segregation of QTL was evaluated based on lack of fit tests of the COMB against the LC and HS models, using comparison-wise tests at the best position under the COMB model. A whole genome scan using 183 markers revealed 131 QTL that were significant at the 5% CW level under at least one model. Of these QTL, 86 showed evidence of segregation within breeds, of which 59 QTL had similar frequencies within the grand-parental breeds (COMB not different from LC), and 27 had detectable frequency differences between the breeds (COMB different from LC). Among the latter, 15 QTL were only detected under the COMB model and another 6 had greater significance under the COMB model than either the LC or HS model. These results demonstrate the utility of implementing the COMB model to increase power to detect QTL and to better characterize their segregation within and between breeds.

Key Words: QTL Mapping, Line Cross, Pig

40 A linear regression model to detect QTL with polar overdominance inheritance in a cross of outbred breeds. J.-J. Kim^{*}, H. Thomsen, K.-S. Kim^{*}, M. F. Rothschild, and J. C. M. Dekkers, Iowa State University.

The objective of this study was to develop least squares regression interval mapping methods to detect quantitative trait loci (QTL) with a unique mode of parent-of-origin effects, polar overdominance (POD), under a breed cross design model in outbred mammals. Under POD, one heterozygous type, as determined by the parent from which the mutant allele was received, differs from the three other genotypes that have equal effect on phenotype. The POD QTL model was derived by restricting parameter estimates from the full imprinting QTL model. For the POD QTL that were detected with suggestive (one false positive per genome scan) linkage evidence by a genome-scan of tests of the POD against the no QTL model (Test 1), two sets of tests were performed at the 5% comparison-wise level at the best position under the POD model to distinguish POD QTL from Mendelian and imprinted QTL: Test 2 to determine whether the full imprinting model explained significantly more variance than the POD model, and Tests 3 to determine whether the POD model fitted better than Mendelian, paternal, or maternal expression models. A POD mode of gene action was declared if the POD model was not rejected in Test 2 and accepted in all tests of Test 3. The POD models and associated tests were applied to data on 16 growth and carcass composition traits in a cross between two commercial pig breeds of Berkshire and Yorkshire with 510 F2 offspring. Based on the three sets of tests three POD QTL were detected with genome-wise (GW) significance for Test 1 ($P < 0.05$) and 17 POD with suggestive significance. The POD QTL with GW significance were for total lipid, loin eye area, and tenth rib back fat in the distal region of SSC6, the distal

region of SSC10, and the proximal region of SSC12. In conclusion, POD models enable detection and characterization of QTL with this unique mode of expression. Identification of POD QTL is based on parent-of-origin effects and requires further investigation to verify specific modes of expression

Key Words: Polar Overdominance, QTL Mapping, Pig

41 Evidence of two QTL affecting fresh and dry-cured ham processing quality characteristics. K. J. Stalder*¹, S. J. Moeller², and M. F. Rothschild¹, ¹Dept. of Animal Science, Iowa State University, ²Animal Science Dept., The Ohio State University.

The objective of this study was to evaluate the effects of two genes, PRKAG3 and CAST, on fresh and dry-cured processing characteristics. Fresh ham data collected included; weight, circumference, thickness, pH, temperature, lipid and moisture content, objective color scores, and color marbling and firmness subjective scores. Processing and curing followed normal commercial procedures. After curing, the hams were weighed and sliced using a band saw. Slices from the approximate center of the ham were utilized to evaluate cured objective color, moisture content, pH, and salt content. A muscle sample weighing approximately 100 g of the semimembranosus was excised from the center cut slices and frozen for later DNA harvest. DNA was obtained from the muscle samples and amplified using PCR using standard procedures. Porcine stress syndrome genotype (Hal 1843TM genotype) was determined following the procedures outlined by Fujii et al. (1991). Napole genotype was determined following the protocol outlined by Milan et al. (2000). The genotype of each ham for the two markers of interest in this study, CAST and PRKAG3, were determined following the methods outlined by Ciobanu et al. (2002) and Ciobanu et al. 2001, respectively. The PRKAG3 marker had no effect on dry-cured ham processing characteristics. The CAST gene marker was a significant source ($P < .05$) variation for cured ham moisture content and tended to be a significant source ($P < .10$) of variation for yield, ham weight loss, salt content and Minolta color change. The beneficial allele is likely different depending whether you are viewing the results from a processors or consumers perspective. The CAST 11 genotype appears to have beneficial effects for processing yield. This genotype would be preferred by processors as they would have more salable ham when compared to hams having CAST genotypes 12 or 22. However, if you are a consumer looking for a drier ham with a more traditional flavor, then CAST genotype 22 is likely the most preferred. This demonstrates that the benefit of a particular CAST genotype can be dependent upon which portion of the pork chain is of interest.

Key Words: Dry-Cured Ham, Ham Processing, QTL

42 Association of a polymorphism in thyroxine binding globulin with backfat depth in a composite population containing 25% Meishan germplasm. G. A. Rohrer*, D. Nonneman, J. J. Ford, and T. H. Wise, USDA, ARS, U.S. Meat Animal Research Center.

A QTL located on the X chromosome for backfat was discovered in a Meishan (ME) x White Composite (WC) population. Recently, we discovered a single nucleotide polymorphism (SNP) in the thyroxine binding globulin gene (TBG) that affects binding affinity of the protein to thyroxine, and is strongly associated with testes size in mature boars. The objective of this study was to determine if the SNP in TBG was associated with backfat. The original study evaluated backcross gilts and barrows weighing about 100 kg. A composite $\frac{1}{2}$ ME $\frac{1}{2}$ WC population was developed and inter se mated for 2 generations. This population was crossed to $\frac{1}{2}$ Landrace $\frac{1}{2}$ Yorkshire pigs and inter se mated for 5 more generations. Backfat of boars (n=60) and gilts (n=136) was determined using ultrasound at about 6 and 7 mo of age, respectively, at the first rib (FRB), last rib (LRB) and last lumbar vertebra (LLM) and each pig genotyped for the TBG SNP. Average backfat (AFT) was also studied. Data were analyzed using SAS GLM with a model that included TBG genotype and age. Gilts and boars were analyzed separately as boars are hemizygous for TBG. TBG genotype was not a significant source of variation for backfat in boars. In gilts the WC TBG allele was dominant to the ME TBG allele. Therefore, the final analysis coded TBG genotypes as homozygous ME or at least one WC allele. TBG genotype was significant for AFT and FRB; LRB approached significance. Homozygotes for the ME allele had 3.9 mm more AFT, 6.0 mm more FRB, 3.2

mm more LRB and 2.5 mm more LLM. These results are similar to the original study where the estimated difference was about 3 mm at each location. While this study does not prove that the TBG SNP discovered causes differences in fat deposition, it does indicate that either TBG or a closely linked gene does affect body composition. Additional studies on this SNP's effect on thyroid function along with intramuscular and subcutaneous fat deposition are underway.

Key Words: Backfat, TBG, QTL

43 Identification and mapping of differentially expressed genes in fetal and postnatal pig skeletal muscle. V. D. Rillington*, N. E. Raney, P. M. Coussens, X. Ren, S. S. Sipkovsky, and C. W. Ernst, Department of Animal Science, Michigan State University.

Tissue-specific differentiation involves the coordinated expression of distinct sets of cell type-specific genes. To increase our understanding of gene expression patterns in developing pig skeletal muscle, we have constructed a cDNA microarray containing 28 clones derived from differential display reverse transcription PCR experiments and 740 clones randomly selected from a porcine skeletal muscle cDNA library developed in our laboratories. All clones were spotted in triplicate and arrayed in 48 8X8 patches. A portion of the bacteriophage Lambda Q gene and spotting solution were included in every patch as positive and negative controls, respectively. The experiment utilized total skeletal muscle RNA from three individual pigs at 60 d of gestation and three individual pigs at 7 wk of age. Each 60-d sample was randomly paired with a 7-wk sample for microarray screening. For two of the arrays, the 60-d sample was labeled with Cy5 while the 7-wk sample was labeled with Cy3. For the third array, the 60-d sample was labeled with Cy3 and the 7-wk sample with Cy5. Normalized fluorescence intensity data was log transformed and analyzed by analysis of variance. Nine genes were identified to be differentially expressed ($P < 0.05$). Eight genes were over-expressed in the 60-d samples and the remaining gene was overexpressed in the 7-wk samples. Validation of differential expression of these genes is underway. Six genes that were more highly expressed in fetal samples were mapped using the INRA-University of Minnesota porcine radiation hybrid panel. Myoglobin, myotilin, paxillin and titin-cap were mapped to pig chromosomes (SSC) 5, 2, 14 and 12, respectively. In addition, an expressed sequence tag (EST) with homology to an uncharacterized fetal mRNA was localized to SSCX and an EST of unknown identity was localized to SSC9. Our results demonstrate that cDNA microarray technology can reveal putative differentially expressed genes in developing skeletal muscle. Such genes are candidates for genes controlling economically important trait phenotypes, and determination of their positions on genome maps facilitates further evaluation of their effects.

Key Words: Muscle Development, Microarray

44 Effects of fescue toxins and heat stress on gene expression in mouse liver. S. Bhusari*, D. E Spiers, W. R. Lamberon, and E. Antoniou, University of Missouri-Columbia.

Fescue toxicosis occurs in cattle fed fescue forage infected with the endophytic fungus, *Neotyphodium coenophialum*, and causes annual losses in excess of \$600 million to the beef cattle industry. Heat stress causes losses averaging \$2.4 billion annually across animal classes and acts synergistically with *Neotyphodium coenophialum* to produce fescue toxicosis in cattle. Mice, previously selected for increased sensitivity to endophyte-infected fescue, were used to study the effects of fescue toxicosis and heat stress. Ninety-five mice were randomly allocated to either heat stress (HS; $34 \pm 1^\circ\text{C}$) or thermoneutral (TN; $24 \pm 1^\circ\text{C}$) conditions and to a diet containing either 50% endophyte positive (E+; 6ppm Ergovaline) or negative (E-) fescue seeds from 47 to 60 days of age. At study end, mice were euthanized and livers weighed and frozen. Mice fed the E+ diet gained less than those on the E- diet. Liver weights were heavier in HS E+ mice than TN E+ ($P=0.01$). Microarrays were printed using 1,353 oligos representing rat genes expressed in liver. Twenty-four mice, six from each of the four treatments (HS E+, HS E-, TN E+, TN E-) were used for analysis of gene expression. Comparison between HS and TN mice revealed 109 genes differentially expressed in liver. Heat stress resulted in a broad induction of genes involved in acute phase reaction, anti-oxidant and drug metabolism, protein metabolism (23%), and genes involved in response to stress (10%).

Key Words: Fescue Toxicosis, Heat Stress, Microarrays

Extension

45 Pre-calving nutrition and management programs for two-year-old cows. J. C. Whittier*, *Colorado State University*.

A female replacement enterprise is needed in beef production systems to overcome the effects of cow attrition in a cowherd. Replacing females may come from either internal or external sources. In either case, heifers must be grown, mated, calved and re-bred to successfully replace the cowherd. In most production systems in the United States and Canada, replacement heifers are mated to calve first at approximately two years of age. These young cows have not yet reached their mature body weight at first calving, therefore there is an added growth requirement to their reproductive and lactational requirements. It is generally accepted, based on numerous research and production observations, that pre-calving nutrition (which is fundamentally reflected as body condition at calving) is a primary driver of the length of the postpartum anestrus period. Recent and on-going research has identified potential opportunities to positively manipulate physiologic responses in young cows through feeding elevated undegradable intake protein or glucogenic precursors. Studies in animal behavior that relate to grazing and foraging behavior indicate that opportunities and interactions for improved nutritional status exist by incorporating principles of animal learning and behavior into heifer development programs. Low-cost strategies designed to meet the nutritional demands of young cows in concert with management programs designed to optimize reproductive performance will facilitate successful replacement programs.

Key Words: Heifer, Replacement, Production Systems

46 Post-calving nutrition and management programs for two-year old cows. J. P. Banta*, D. L. Lalman, and R. P. Wettemann, *Oklahoma State University*.

When managed in the same contemporary group, first service conception rates are similar among primiparous and multiparous cows. However, increased postpartum interval to first estrus (PPI) and decreased pregnancy rates are typical of primiparous cows as compared to multiparous cows. Consequently, considerable time, effort, and feed resources go into achieving acceptable pregnancy rates of primiparous cows. Body condition score at calving is the most important factor that influences PPI and pregnancy rates. However, numerous postpartum management and nutritional strategies have been evaluated to improve reproductive performance of primiparous cows. The more extensively studied strategies include early weaning, positive postpartum energy balance, lipid supplementation, UIP supplementation, and bull exposure. Early weaning calves at six to eight weeks of age substantially increases pregnancy rates and decreases PPI in primiparous cows. This improvement is due to reduced nutrient requirements of the cow as well as hormonal changes associated with cessation of suckling. Postpartum energy restriction increases PPI and decreases conception rates, regardless of parity. In nearly all experiments reviewed, positive postpartum energy balance was reported to either reduce PPI, increase conception rate or both in primiparous cows. Most studies with postpartum lipid supplementation report no reproductive benefits. A moderate level of postpartum UIP supplementation has been reported to improve reproductive performance. Prebreeding bull exposure has minimal and inconsistent effects on PPI in primiparous cows. Currently, there is no single postpartum supplementation strategy that consistently maximizes or improves reproduction in primiparous cows. Consequently, managing primiparous cows to calve in body condition score of 6 or higher and providing adequate nutrition postpartum to insure minimal or no condition loss is the most practical and proven strategy to maximize reproductive performance. Early-weaning also consistently results in improved reproductive efficiency when primiparous cows are nutritionally deprived.

Key Words: Primiparous Cows, Nutrition, Reproduction

47 Health programs: Analysis, design and implementing programs for the two-year old cow. G. L. Stokka*, *Pfizer Animal Health*.

Analyzing and designing a health program for cow-calf operations requires knowledge of the ranch resources and environment as well as the current genetic, nutrition, management and biosecurity program. All of these areas are interrelated, and must be considered in order to assess

and manage the risk of disease and reduce the risk of production and economic loss. To begin this process the following four points must be addressed: 1) Identification of potential risks and economic losses related to production and disease, 2) Determining and understanding appropriate benchmarks for production, disease and cost of production, 3) Diagnosing the root cause of the problem when benchmarks are not achieved and making appropriate corrections, 4) Using appropriate records which verify results. The two-year old cow is at the greatest risk of failing to meet herd benchmarks in financial and production parameters. This is most often due to the additional nutritional requirements of this group, which, if not met, can result in a higher percentage of this group failing to become pregnant during the subsequent breeding period and ultimately lowering pounds of weaned calf/cow exposed. In addition, this group may have reduced herd immunity and generally produces reduced colostrum quantity and quality, resulting in greater risk of disease and potentially, reduced production in calves born to this group. As a result this group may require more inputs on all aspects of the health program. Risk assessment may include the specific disease risks to biosecurity such as raising or purchasing females that are persistently infected with BVDV, or infected with *Mycobacterium paratuberculosis*. In addition, some assessment is necessary as to the risk of exposure to common infectious reproductive disease pathogens such as IBR, leptospirosis, trichomoniasis, vibriosis and neoplasia for which vaccination protocols may be implemented. The analysis and design of a health program requires a scientific and logical approach. With proper implementation they can significantly reduce the risk of disease and economic loss.

Key Words: Benchmark, Disease, Risk

48 Appropriate genetic packages: where should selection pressure be placed? J. L. Evans*, *Department of Animal Science, Oklahoma State University*.

Selection decisions for genetic improvement of a two-year-old cow are an important component of a breeding program. The two-year-old cow experiences higher production and financial risk compared to other age groups because of additional energy demands for growth, lactation, and pregnancy. A financial risk is also associated with development costs that require multiple years of production to cover development expenses. These factors increase risk of culling for failure to meet breeding program goals. Therefore, a breeder's selection decisions should identify animals with appropriate breeding values to minimize failure. Breeding program design is a critical step toward development of a two-year-old cow. Traits emphasized for development of a two-year-old cow should be aligned with herd production goals, manage genetic antagonisms, and emphasize profit. The development of efficient and productive replacement females requires emphasis on reproduction. Sire selection decisions must emphasize reproductive performance, in addition to production and carcass traits. For the commercial cattle enterprise, reproduction is three times more economically valuable than carcass traits. Therefore, National Cattle Evaluation has developed several Expected Progeny Differences (EPD) to assist genetic change in traits important to replacement female development. In combination with management, these new EPD are effective tools in the development of replacement females and provide insurance against removal. Some of the new traits are heifer pregnancy, stayability, and calving ease. Traits, such as heifer pregnancy, were developed because of a deficiency in reproductive trait EPD and the implementation of Whole Herd Reporting. The selection of replacement females with genetic merit to meet the breeding program goals has improved with availability of new EPD; however, researchers recognize the need for decision support tools to assist producers with defining breeding objectives to correctly identify profitable replacement females.

Key Words: Beef Cattle, Genetic Improvement, Selection

49 Economic and tax implications for managing two-year olds. R. Clark*¹, T. Patterson², K. Creighton¹, and T. Barrett¹, ¹University of Nebraska-Lincoln, ²South Dakota State University.

Two-year-old beef females can be raised or purchased. These two strategies have different economic and tax implications. Success for rebreeding the first calf heifer is a challenge and has a major impact on the present value of the replacement female. The timing of the replacement in the

beef cattle price cycle also influences that value especially since the opportunity cost of the heifer calf is one of the major costs involved in developing a replacement. That opportunity cost can be greatly impacted by the price cycle. Research has shown that rebreeding success can be enhanced at a relatively low cost and thus increase the value of the replacement by about \$20 per head for an average 5 percent improvement in pregnancy rates. Rebreeding of June born replacement females offers a different challenge than those females born in March. However, proper timing of protein supplement for the June born females exposed for the second time has been shown to greatly improve breeding success. Unpublished data show a 10 percent increase in pregnancy rates for the second breeding from protein supplement fed beginning in July through the breeding period (mid-September) for heifers that were exposed for the first time at the same time as mature cows. The costs for raising replacement females become expenses against income for income tax purposes for the cash-filing producer. Purchased females are expensed on the depreciation schedule over varying number of years depending on whether or not the accelerated depreciation under Section 179 is used. If 179 is used the females may qualify for either a 30 or 50 percent bonus depreciation. Without the bonus the purchased female will be expensed out over a 5-year period. Unless section 179 is used, the rate of reclaiming the expenses for a purchased female would be less than the time for expensing out a raised replacement female. Both raised and purchased replacements are subject to capital gains tax but that is true of purchased only if there is a gain in the sale price over the book value. The tax differences may or may not be important in the replacement decision depending on tax bracket and the goals of the producer.

Key Words: Economic, Tax, Heifers

50 Using a systems approach for profitable management of two-year-olds. Barry H. Dunn*¹, ¹*South Dakota State University.*

Due to the low reproductive rates inherent to the species, high turnover rates in cowherds, and the investment of getting a female into production, the management of two-year-old cows (2YC) has been identified as a high leverage point for the increased profitability of the beef cow-calf enterprise. For 2YC, the combination of sub-par rebreeding performance, the loss of potential genetic value in other economically important traits, and low market value due to weight, condition, and market discounts, creates the potential for financial loss. Strategies for addressing the low reproductive rates of 2YC often focus on the areas of nutrition, genetics, and special management alternatives. A systems approach would include: 1)the measurement of the reproductive rates of the cowherd, and its replacement rate, 2)the financial cost of raising a replacement female, 3)the marginal cost of changes in reproduction rate, 4)the net present value of all age groups of females in the herd, and 5)the evaluation of technologies that would improve reproduction and their associated costs. The basis of this approach is the principle that there is a point of diminishing returns based on the limitations placed on an enterprise by the natural environment, financial constraints on the enterprise from within the business organization, the external marketplace, and the genetic potential of the beef animals. Systems analysis may identify alternative high leverage points for reducing the costs of raising replacement heifers or improving the reproductive performance of 2YC. Improving the marketing of cull animals may emerge as an effective management intervention in combination with other strategies or used separately. Improving cow longevity could reduce the overall need for replacements, thus lowering the impact of low reproduction rates. Synchrony between nutrient demands, dictated by potential milk production and mature size, and available feed resources can be analyzed. It may also reveal unexpected outcomes of intervention strategies and sensitize decision makers to delays in response. Systems analysis provides an alternative path to understand problems in the beef cattle enterprise.

Key Words: Systems Approach, Beef Cows, Management

51 Biological and economic variance in dairy replacement heifer management. P. C. Hoffman, *University of Wisconsin-Madison.*

Raising dairy heifers at proper biological growth rates at an economical cost is the standard goal of dairy heifer management programs. The dairy industry serendipitously coalesces these broad goals into single

quantitative mean benchmarks for proper heifer growth and rearing cost. For example, it is commonplace to find field recommendations that Holstein heifers should be reared at 800 g/d and heifer rearing cost should be \$1,300.00/heifer. While logical, these single benchmarks offer little to improve the management of dairy replacement heifers on a day-to-day basis because mean benchmarks do not assess biological and economic variance in the management systems. The incidence or occurrence of failed passive transfer, respiratory disease, improper nutrition, inadequate resting surfaces, hoof disease, crowding, and other events creates variance in heifer growth rates which diminish heifer development. To date the dairy industry has had few tools available to track and monitor phenotypical sources of variance in dairy replacement heifer management. The new *Raising Dairy Replacements* publication developed by the University of Wisconsin, Minnesota, Illinois, and Iowa State University now offers comprehensive growth charts and new computerized graphics tools to track, monitor, and assess sources of biological variance in heifer rearing systems. The publication with supporting software was developed to aid dairy producers, heifer growers, and industry professionals in advancing dairy heifer management systems. In addition the publication contains software to make full economic assessments of heifer rearing cost and potentially identifies areas in which cost reductions in the heifer management program can be made. The publication and companion computer programs also facilitate the assessment of labor and management efficiencies and feed cost associated with the heifer rearing enterprise. The new "Raising Dairy Replacements" publication offers in-depth educational materials designed to assess biological and economic variance associated with rearing dairy replacement heifers.

Key Words: Heifers, Education, Growth

52 Health management for dairy calves. S. Godden*¹ and R. Wallace², ¹*University of Minnesota,* ²*University of Illinois.*

Raising Dairy Replacements (MidWest Plan Service, 2003) is an up-to-date and comprehensive guide on the topic of managing the replacement heifer from birth to first calving. The second chapter in this publication, *Health Management for Dairy Calves*, seeks to educate producers on important calfhood diseases, as well as to provide practical and effective recommendations to help producers improve the health and management of young calves. The chapter begins by offering recommendations for management of the newborn calf, including guidelines for colostrum management. Guidelines for vaccination of the dam during the dry period, and options for vaccination and/or antibody supplementation to the newborn calf are provided. Several important diseases of young calves are discussed including scours, pneumonia, septicemia, ear infections, parasite infections, hernias, and others. As an example of the type of information provided, for the topic of scours there is a discussion of the common causative agents, when infections occur, and methods of transmission. The discussion stresses the importance of fluid and electrolyte-replacement therapy as part of the supportive therapy necessary for successful treatment, and presents guidelines on how to evaluate the severity of dehydration in scouring calves. A sample protocol is provided that producers could adopt or modify for daily monitoring of calves for the detection, diagnosis, and treatment of common diseases. Biosecurity measures that may be implemented to reduce the risk of introducing new diseases to the farm are also presented. One valuable tool, available on the CD format of the publication, is a *Pasteurizer Evaluator* spreadsheet. Producers can enter farm-specific variables into the spreadsheet to calculate the predicted payback period for implementing a pasteurized waste milk feeding program on their operation, as compared to a milk replacer feeding program.

Key Words: Calf, Health, Management

53 Managing the dairy cow and calf at parturition. H. D. Tyler*, *Iowa State University.*

Management of the pre-weaned calf is a critical component of a heifer enterprise and often dictates the profitability or lack of profitability of the entire dairy farm. The publication "Raising Dairy Herd Replacements" provides a valuable tool for educating producers about the science behind management decisions in a user-friendly format. The goal of the chapter entitled *Calf Development and Birth* was to provide the necessary background for producers to understand the impact of sire selection decisions and herd nutritional status on pregnancy outcomes, and to use this knowledge to make rational decisions regarding managing

the parturition process. In order to insure that proper management decisions are reached, a thorough understanding of the complex biological processes that direct fetal and placental growth and initiate the process of parturition is necessary. Factors that directly alter fetal and/or placental development have the potential to adversely impact parturition processes and subsequent survivability of the calf. In addition, the quality of management during the birth process directly affects the relative success or failure of postnatal management practices that are directed towards enhancing calf performance. This review will discuss nutritional, endocrine, and genetic control of fetal and placental development, as well as the use of the publication and associated software in the development of management practices designed to minimize stress for both the cow and calf through the process of parturition.

Key Words: Calf, Parturition, Dystocia

54 Assessing and improving reproductive management in dairy replacements. P. M. Fricke* and H. Rivera, *University of Wisconsin - Madison*.

The overall goal of a dairy replacement heifer program is to rear heifers to reach a desired age and body weight so that they initiate puberty, establish pregnancy, and calve easily at a minimal cost. Research has consistently supported that Lifetime milk yield, 305-day lactation yields, and lifetime profit of replacement heifers are maximized when heifers calve for the first time between 23 and 25 months of age. Age at first breeding coupled with reproductive efficiency to first and subsequent breedings determines age at first calving because gestation length is a fixed interval (282 days) once conception occurs. Thus, the major reproductive challenge for breeding age heifers is to achieve conception by 14 to 16 months of age. Artificial Insemination (AI) breeding programs have long been recommended for dairy producers that raise heifers for herd replacements because of the proven genetic and economic advantages of using AI compared with using natural service bulls for breeding dairy cattle. Despite the overwhelming economic advantages of using AI for breeding heifers, it has been estimated that only 55% to 68% of dairy heifers in the U.S. are serviced using AI. Based on these statistics, heifers continue to be the most underutilized genetic resource on dairy farms. The primary reason for synchronizing estrus or ovulation in dairy heifers is to facilitate use of AI. Many estrus synchronization protocols have been developed for cattle using exogenous hormones including progestogens, prostaglandins (or PG analogs), gonadotropin-releasing hormone (GnRH), and estrogens alone or in various combinations to control the physiology of the reproductive cycle and synchronize estrus behavior. Synchronized breeding protocols used in conjunction with AI allow producers to more precisely manage age at first AI service and age at first calving in heifers. Results from a series of experiments from our laboratory have shown that hormonal protocols that synchronize ovulation and allow for fixed-time AI may provide management tools to increase use of AI and improve reproductive efficiency to first breeding in dairy heifers.

Key Words: Reproduction, Dairy Heifers, Synchronization of Ovulation

55 Starting them right, development and support of immune function in the newborn calf. S. T. Franklin*, *University of Kentucky*.

Morbidity and mortality of dairy calves are largely a result of exposure of calves to disease causing organisms and a lack of transfer of passive immunity from the dam to the calf via colostrum. Exposure to disease-causing organisms may result from poor sanitation during collection of colostrum or poor sanitation in the environment of the calf. Reasons for the lack of transfer of passive immunity to calves may include lack of sufficient immunoglobulins provided to calves, improper timing of feeding, lack of sufficient specific antibodies in colostrum, and poor absorptive capabilities of calves. Several management techniques may be employed to improve transfer of passive immunity and disease resistance. Some of these techniques include management of cows during the dry period to enhance colostrum quality, improved management of the calving environment and colostrum acquisition methods to decrease exposure of calves to disease causing organisms, and enhancement of the quantity of immunoglobulins provided. Additional management techniques may be needed to treat calf morbidity. These include use of antibiotics and provision of supplements that may enhance immune function and/or disease resistance. This review will present information regarding recent studies

evaluating various management strategies for provision of immunoglobulins to calves and supplementation of calves with additives that may enhance immune function and/or disease resistance. Additionally, information will be reviewed regarding effects of environmental temperatures on immunoglobulins in colostrum and the immune system of calves.

Key Words: Calves, Immune System, Colostrum

56 Management and housing alternatives for the growing dairy heifer. H. Chester-Jones*, *University of Minnesota Southern Research and Outreach Center*.

Raising dairy heifer replacements can represent 15 to 25% of the total costs of milk production on dairy operations. Feed, labor and building expenses including operational overheads are key costs involved in raising heifers. Recent surveys on Wisconsin dairy and custom heifer raising operations indicated a range in total costs from 118to435/calf from birth to 9 wk-old and 950to1743/heifer from post weaning to pre-freshening. Within these costs, labor management efficiencies varied from 3 to 25 calves/hr from birth to 9 wk-old and 20 to 106 heifers/hr for the post weaning to pre-freshening period. Functional housing design alternatives should provide a healthy environment for the animals and the caretaker, efficient use of labor and effective use of farm resources. Labor management considerations include feeding, cleaning, moving animals, monitoring animals, health, safety and manure handling. Considerations for the animals will include minimizing stress factors (air quality, comfort, adequate resting space, adjustment to environmental changes, weaning, vaccinations, transitional grouping and feed changes), optimizing animal welfare, growth and health (overall bio-security). Housing facilities should be designed for 20 to 25% above needed capacity to allow for an all-in-all-out approach and proper sanitation between animal groups. Development of Standard Operating Procedures and Management Teams are recommended to help monitor and identify critical control points for each enterprise to implement positive management and cost reduction changes. This paper will examine cost and labor management efficiencies of alternative housing options for calves and heifers including renovation of existing barns, individual or group housing, fabric and post frame structures, transitional group housing, rotational grazing, monoslope bedded pack barns, gated scrape and bedded pack barns, freestall barns, open feedlot and mound systems.

Key Words: Housing Alternatives, Management, Dairy Heifers

59 Developing systems to minimize heat stress in dairy cattle. J. F. Smith, M. J. Brouk, and J. P. Harner, *Kansas State University*.

Heat stress reduces feed intake, milk production, health and reproduction of dairy cows. A trial completed in Missouri showed that lactating cows under heat stress decreased intake 6-16% as compared to thermal neutral conditions. In addition to a reduction in feed intake, there is also a 30 to 50% reduction in the efficiency of energy utilization for milk production. In many parts of the U.S., milk production and reproductive performance drastically decline during periods of heat stress. The dairy cow can be managed and cooled to minimize the impact of heat stress. Heat stress can be reduced by providing a cooler environment (cooling the air), by soaking the cow and evaporating water off her skin surface (cooling the cow) or using a combination of these two methods. Evaporative cooling can be used to cool the air around the cow. On dairies producers have used tunnel ventilation with evaporative pads and combinations of fans and high-pressure sprayers to cool the air around the cow. This method works well in arid climates. As water is evaporated into the air temperature will drop and humidity will increase. Low-pressure soaker and fan systems can be used to effectively wet and dry cows increasing hest loss from the cows. Evaporating water off the skin works well in humid and arid climates. Dairy cows can be soaked in the holding pen, exit lanes, and on feedlines. The goal should be to maximize the number of wet-dry cycles per hour. Recent research would indicate that a combination of using evaporative cooling to cool the air and a low-pressure soaker system to soak cows could be used to effectively manage heat stress in hot humid climates. Matching the cooling strategy with the climate is essential to manage the impact of heat stress in dairy cattle. Priorities for reducing heat stress in dairy facilities are; improve water availability, providing shade in the housing areas and holding pen, reduce walking distance, reduce time in the holding pen, improve holding pen ventilation, add holding pen cooling

and exit lane cooling, improve ventilation in cow housing areas, cool dry cows, cool fresh cows and early lactation cows, cool mid & late lactation cows.

Key Words: Heat Stress, Dairy Cattle, Milk Production

60 Mastitis diagnostics, prevention, and therapy technologies and strategies for transition cows and heifers. L. Timms*, *Iowa State University.*

50% of mastitis occurs during the dry or non lactating period with highest susceptibility week 1 post dry off and last week prior to calving, often resulting in clinical mastitis post calving with environmental organisms. Recent research showed 50% of teats open 1 week post dry off, 24% open after 6 weeks (range 10-70%) (Dingwell et.al, *Prev. Vet Med* 2003) and 20% of heifer teats open at calving (Williamson, *NZVJ* 1995). Cows > 45# milk at dry off were 1.8 times more likely for teat closure failure. Strategies and technologies for early diagnosis, prevention, and therapy for mastitis are critical to address dry period and heifer mastitis. Dingwell et al. (*Can Vet J* 2003) showed overall sensitivity (SE) and specificity (SP) of the California Mastitis Test (CMT) were 68.8% and 71.5% the first week post calving. SE, SP, positive (PPV) and negative (NPV) predictive value for day 1 and 4 post calving were 73.3, 66.5, 23.2, 94.8, and 82.4, 80.6, 32.6, and 96.3 %, respectively. This shows the most accurate part of this test is identifying uninfected animals, and other data such as culture, etc are critical before basing treatment on positive CMT. Two 14 month field trials were conducted where a persistent barrier teat dip sealant was applied once at dry off, then starting one week pre-calving, with dip re-applied as needed to provide coverage for > 7 days pre calving. Results showed significant reductions ($p < .05$) in overall IMI (31-37%), major pathogen IMI (48-60%); environmental strep.(ES) IMI (54-63%) and coliform IMI (57%, trial 2 only) (Timms, *NMC-AABP*, 2001). Recent work evaluating an internal teat sealant showed similar results (33% decreased IMI, 83% reduction in clinical ES IMI) (Godden et al., *NMC* 2003). Recent work has shown 95 and 50% of heifers with IMI 14 day pre calving and at calving, respectively, primarily with coagulase negative staphylococcus. A single intramammary infusion of a lactating cow antibiotic 10-14 days precalving resulted in significant lower IMI and 1100 # increased milk production in jersey heifers (Oliver, *JDS* 2003). Current trials to validate heifer therapy will be presented.

Key Words: Mastitis, Transition Cows and Heifers, Teat Sealants

62 Comparison of management practices between beef quality assurance certified and non-certified producers in Montana. L. M. Duffey*, J. A. Paterson, J. E. Peterson, M. C. King, W. T. Choat, and K. M. Rolfe, *Montana State University.*

A survey was conducted to determine record keeping, health management, marketing strategies, and perceptions of industry issues by MT beef producers. A 38-question survey was mailed to 1000 beef producers of which 500 were Beef Quality Assurance (BQA) certified (231 surveys returned or 46%) and 500 were not BQA (non-BQA) certified (116 surveys returned or 23%). Results of the independent sample *t*-test showed BQA producers kept more ($P < 0.05$) records (cowherd inventory, description, calf birth weights, vaccination, feed) than non-BQA producers. Ninety-seven percent of BQA producers vaccinated in the neck compared to 87% of non-BQA producers ($P < 0.05$). The armpit was the second most commonly used injection site. BQA producers used modified live vaccines more ($P < 0.05$) than non-BQA producers. Although there was no difference ($P > 0.10$) between treatments, only 32% indicated they gave a booster of a killed vaccine after the initial vaccination. Fifty-nine percent of all producers indicated they implanted calves. There were no differences ($P > 0.10$) between treatment groups in the method of marketing feeder calves; the most common method was the order buyer (46%) followed by the auction market (26%). Eighty-six percent of all producers marketed calves to the same buyer two or more years. Thirty-three percent of all producers indicated their buyer required information on the calves with vaccination history requested most frequently (36%). A majority of all producers (94%) indicated they were somewhat to very concerned about food safety issues in the industry. More ($P < 0.05$) BQA producers (59%) than non-BQA producers (47%) indicated that a national animal identification program should be implemented in the U.S. However, 32% of all producers said a national identification program should be mandatory while 29% said

it should be voluntary. Results of this survey are being used to better determine the extension programming needs of MT cattle producers.

Key Words: Beef Quality Assurance, Animal Identification, Montana

63 Effect of postweaning calf health on feedlot gain and quality grade. W. D. Busby*¹, D. Strohbehn¹, P. Beedle¹, and L. R. Corah², ¹*Iowa State University*, ²*Certified Angus Beef LLC.*

A total of 6,618 calves fed at eight Iowa feedlots were used to evaluate the effect of postweaning health on feedlot gain and carcass quality grade. The calves, representing 12 states, were consigned to the Iowa Tri-County Steer Carcass Futurity and were weighed upon arrival, after 35 days, at re-implant, and prior to harvest. A common dietary energy level was utilized at each feedlot. Calf health was classified as no treatment (NT; N=5,500), single treatment (ST; N=575), or two or more treatments (2T; N=543). The predominant cause of treatment was respiratory problems. Calves were sorted and harvested when they were visually evaluated to have one centimeter of fat cover. Feedlot ADG was 1.39, 1.33, and 1.30 kg/day for the NT, ST, and 2T calves, respectively. Calf sex, origin of calf (Southeast vs. Midwest), season of delivery (fall vs. spring), and color (black vs. red vs. white) all affected feedlot gain. The percent USDA Prime, Choice, Select, and standard for NT, ST, and 2T calf carcasses were 1.87, 70.3, 25.3, and 2.6; 1.05, 62.9, 30.1, and 5.9; and 0.9, 57.9, 30.6, and 10.6, respectively. A total of 4,499 calves were Angus-type calves eligible for *Certified Angus Beef*[®] (CAB[®]) acceptance. CAB[®] acceptance percentages for NT, ST, and 2T carcasses were 27.1, 24.2, and 18.7, respectively. CAB[®] acceptance rates were also impacted by calf sex (steers = 14.7% vs. heifers = 23.7%) and season of feedlot delivery (spring = 14.5% vs. fall/winter = 23.8%). Calves treated two or more times upon feedlot arrival had reduced feedlot gain, reduced quality grade, and reduced CAB[®] acceptance rate compared to untreated calves.

Key Words: Beef, Health, Quality Grade

64 Standard ileal digestible isoleucine and tryptophan ratios to lysine for late finishing pigs. B. V. Lawrence*¹, J. D. Hahn¹, S. A. Hansen¹, J. Hansen¹, E. Hansen¹, R. Musser¹, and M. Rademacher², ¹*Hubbard Feeds Inc.*, ²*Degussa AG, Feed Additives, Germany.*

In Exp. 1, 1,007 Duroc pigs (Compart Boar Store Line 442 X D100) weighing 93.5 ± 4.2 kg were allotted to Ile:Lys ratios of 0.55, 0.65, 0.75, or 0.85. Corn-soybean meal based diets were formulated to 0.61% available Lys and 6% added fat. Diets had a Trp:Lys ratio of 0.15. Pigs were housed in 2.74 X 5.49 m pens with 20 - 21 pigs/pen. During the 28-d trial, no treatment differences ($P > 0.10$) were detected. Pigs gained 649 ± 61.4 g/d, consumed 2445 ± 184.8 g/d with a GF of 0.26 ± 0.02 . At the start and termination of the trial, 640 pigs (97.9 ± 6.2 kg, and 114.6 ± 5.8 kg respectively) were scanned by real-time ultrasound (RTU) for last rib fat (LRF), tenth rib fat (TRF), and tenth rib loin eye area (LEA). There was no treatment effect on carcass measurements ($P > 0.10$). Gain and rate of lean and fat accretion were lowest ($P < 0.05$) for pigs fed the 0.65 Ile:Lys ratio. In Exp 2, 887 Duroc pigs (Compart Boar Store Line 442 X D100) weighing 80.6 ± 2.7 kg were used in a 30-d 2 X 2 factorial (0.15 vs. 0.22 Trp:Lys and 0.55 vs. 0.80 Ile:Lys ratios) trial. Pigs were housed in 2.47 X 5.79 m pens with 19 - 20 pigs per pen. Corn-soybean meal based diets were formulated to 0.65% available Lys and 6% added fat. Pigs fed the 0.22 Trp:Lys ratio had a higher ($P < 0.05$) ADFI ($2,633$ vs. $2,777$ g/d) than those fed the 0.15 ratio. Across all treatments, ADG was 912 ± 27.4 , intake was 2.70 ± 0.19 kg/d, and gain/feed averaged 0.35 ± 0.03 . At the end of Exp. 2, 640 pigs weighing 112.9 ± 8.7 kg were scanned via RTU as described for Exp. 1. Increasing the Trp:Lys ratio tended ($P < 0.10$) to decrease TRF and LRF by 0.50 and 0.40 mm respectively. Increasing the Ile:Lys ratio from 0.55 to 0.80 increased ($P < 0.01$) LEA by 1.2 cm². These results suggest that short term (<30-d) reduction in the Trp and Ile:Lys ratio in late finishing will not influence pig performance, but will have a minor, repeatable effect on carcass composition.

Key Words: Tryptophan, Isoleucine, Pigs

65 Effect of removing market ready pigs on performance of their pen mates. M. Knauer*¹, K. J. Stalder¹, D. Hentges², H. G. Kattesh², D. W. Newcom¹, T. J. Baas¹, and J. W. Mabry¹, ¹Dept. of Animal Science, Iowa State University, ²Dept. of Animal Science, University of Tennessee.

Data from 649 barrows and gilts were utilized to determine the effect of removing market ready pigs on performance of pen mates. Following the animal care and use committee guidelines, all pigs were provided 0.73 m² / pig of floor space. Pigs were randomly assigned to one of three treatments: C (control) consisting of 26 pigs / pen that were marketed as a single unit; SP25 (split marketed - 25%) consisting of 26 pigs / pen in which the heaviest 25% of pigs were marketed two wk prior to their pen-mates; or SP50 (split marketed - 50%) consisting of 26 pigs / pen in which the heaviest 50% of pigs were marketed two wk prior to their pen-mates. Animals were weighed on test at 10 wk of age and at all marketing dates. Individual tenth rib backfat (BF10) and loin muscle area (LMA) measurements were ultrasonically evaluated on all pigs one wk prior to marketing. Pen feed intake was calculated by feed weigh-back to determine group feed intake, feed efficiency (feed / gain), and efficiency of lean gain (feed / lean gain). Average daily gain (ADG), days to market (DAYS), and average daily lean growth on test (LGOT) were calculated from the data collected on individuals. A mixed linear model was used for individual and pen traits. Pen was the experimental unit of measurement in this study. For individual traits, fixed effects included treatment and replicate. For pen traits, treatment and replicate were included as fixed effects in all models. On-test weight was used as a covariate in the analysis of ADG, LGOT, group feed intake, feed efficiency, and efficiency of lean gain. Off-test weight was used as a covariate in the analysis of AGE, BF10, and LMA. Total pig days per pen was used as a covariate for group feed intake, feed efficiency, and efficiency of lean gain. Pen within treatment was included in all models as a random effect. No treatment differences were detected for any of the traits evaluated. Evidence suggests removing 25% or 50% of market ready pigs two wk prior to the final marketing date does not affect total pen performance.

Key Words: Swine, Split-marketing, Performance

66 Effect of technician, machine, and animal body composition on accuracy of ultrasonic measures of backfat and loin muscle area in swine. D. W. Newcom¹, J. L. Burkett*¹, T. J. Baas¹, C. R. Schwab¹, S. J. Moeller², and K. J. Stalder¹, ¹Dept. of Animal Science, Iowa State University, ²Dept. of Animal Sciences, The Ohio State University.

Records (n = 11,305) from the 1998 to 2003 National Swine Improvement Federation (NSIF) ultrasound certification programs were used to determine the effect of technician, machine (A-mode and B-mode: Aloka 500, Classic Scanner 200), and level of animal fat depth and loin muscle area on the accuracy of tenth rib off-midline backfat (BF10) and loin muscle area (LMA) measured on live pigs. A mixed linear model was utilized with a fixed effect for machine and carcass backfat and loin muscle area as covariates. Year and technician (n=78) nested within year were included as random effects. Dependent variables in the model were the difference between scan and carcass measures for BF10 (BFD) and LMA (LMD) and the absolute value of these differences (ABFD and ALMD, respectively). The absolute value of BFD and LMD were grouped into classes (n = 5) for each trait and pigs were grouped into two BF10 and two LMA groups for a frequency analysis. Technicians were classified by certification status as: failed to meet certification standards for BF10 and LMA; met certification standards for BF10; met certification standards for BF10 and LMA. The effect of technician within year accounted for 25.1% and 52.8% of the variation in BFD and LMD, respectively. Technicians who failed to certify for BF10 had ABFD greater than 5.1 mm on 32% of the pigs measured while technicians who certified for BF10 had only 11% of measurements greater than 5.1 mm for ABFD. Technicians who certified for LMA had ALMD greater than 6.45 cm² on 5.5% of pigs while technicians who failed to certify had ALMD greater than 6.45 cm² on 24% of pigs measured. Across certification programs, technicians using A-mode machines had larger BFD and ABFD when compared to those using either B-mode machine. No difference was detected between the B-mode machines for LMD, but technicians using the Aloka 500 had larger ALMD than technicians using the Classic Scanner 200. Technician ability, machine type, and animal body composition did impact the accuracy of BF10 and LMA measured on live pigs.

Key Words: Swine, Ultrasound, Accuracy

67 The Iowa State Fair 4-H Swine Derby Contest provides educational experience for youth. B. D. Martin*¹, T. J. Baas¹, and K. J. Stalder¹, ¹Iowa State University.

Swine tested derby contests are programs in which performance and carcass merit are combined, emphasizing the economics of pork production. The Iowa State Fair 4-H Swine Derby Contest provides a setting that encourages 4-Hers to learn and apply practical methods of production, management, marketing, and university research. Youth begin by nominating up to 20 crossbred and 20 purebred barrows or gilts at weigh-in. Entries must be brought to designated weigh-in sites to be verified and weighed in by state officials. At weigh-in, pigs are given an official ear tag, ear tattoo, and hair samples are collected for identity verification. Pigs must be weighed on test at no more than 18.14 kilograms, and are fed at the farm until show day. At the fair, all entries are weighed and scanned for tenth rib backfat (BF10) and loin muscle area (LMA) using real-time ultrasound. The live show judge is provided ADG on each pig, and entries are placed on performance and phenotype. All pigs are ranked on standardized fat-free lean gain per day on test using the National Pork Producers Council formula for predicting pounds of lean using real-time ultrasound. Based on these results, the top 100 pigs and additional nominated pigs form the carcass contest. These pigs are evaluated in the packing plant for BF10, LMA, and meat quality. The final placing is based upon lean gain per day on test using starting weight, carcass weight, days on test, BF10 and LMA. From 1999 to 2003, an average of 474 pigs/year have been shown. Average daily gain has improved from 813 g/d to 885 g/d, while BF10 has decreased from 21.8 mm to 16.8 mm and LMA has increased from 42.8 cm² to 48.5 cm². The average number of pigs in the carcass contest is 144/year during the same time period. These animals' ADG has improved from 858 g/d to 981 g/d while BF10 decreased from 20.3 mm to 16.8 mm and LMA increased from 43.6 cm² to 54.3 cm². These improvements and the positive feedback from youth and parents illustrate the educational value of this program.

Key Words: Performance, Carcass Merit, Swine

68 Use of a mobile ventilation laboratory (VL) for hands-on training of pork producers in building ventilation. S. Pohl¹, R. Thaler*¹, M. Brumm², R. Stowell², J. Harmon³, D. Stender³, J. Weiss³, L. Johnston⁴, and L. Jacobson⁴, ¹South Dakota State University, ²University of Nebraska, ³Iowa State University, ⁴University of Minnesota.

Ventilation of confinement swine buildings is becoming increasingly complex as sophisticated, computerized controllers are being installed in commercial production facilities. Often, workers charged with maintenance and operation of these ventilation systems have a superficial, if any, understanding of how computerized controllers function and very limited knowledge of basic ventilation principles. This educational need encouraged faculty from four universities with support from Pork Check-off funds to work cooperatively to develop a one-day workshop using a mobile VL that was designed and constructed at South Dakota State Univ. Extension swine specialists and agricultural engineers team up to deliver classroom presentations and demonstrations using the VL. The VL (1.8 m x 2.5 m x 2.5 m) is equipped with three types of air inlets, three fans, a heater, and a computerized controller and is instrumented to monitor static pressure, air flow rate, temperature, and humidity. Hands-on exercises include measurement of static pressure and air speed, calculation of approximate ventilation rate and an examination of fan motor curves. Students complete worksheets which allow them to gain first-hand experience in operating a ventilation system and monitoring results of their operational adjustments. In lectures, students learn environmental needs of pigs, principles of air exchange and distribution, cooling and heating of swine buildings, and troubleshooting ventilation systems. The mobile VL is moved to workshop locations on a trailer pulled by a small truck. Through October 2003, 14 workshops have been conducted in 14 locations throughout four states for 380 students. Exit surveys indicate that students value the information gained in the workshop at 1,000 to 5,000 per operation. These students care for 570,000 sows and 8.9 million growing pigs. This educational effort demonstrates a need for continual training of animal caretakers in basic pig husbandry and facility management procedures, and that pork producers and allied industry personnel respond favorably to a hands-on learning format.

Key Words: Ventilation, Hands-On Training, Swine

69 Initial combination implant effects on steer performance and carcass development throughout the finishing period. W. T. Small*, S. I. Paisley, and W. J. Means, *University of Wyoming, Department of Animal Science.*

Our objectives were to evaluate implant effects (trenbolone acetate + estradiol; TBA+E₂) on live performance, back fat (BF), ribeye area (REA), estimated intramuscular fat (%IMF) development, and Warner Bratzler shear (WBS) force determination in finishing steers. Eighty Angus × Gelbvieh crossbred steers (303 ± 2.1 kg) were blocked by weight and randomly assigned to one of 16 pens. Pens were randomly assigned to either control (no implant) or implant treatments. On d 11, initial ultrasound measurements were taken and implant steers received a single combination implant containing 120 mg trenbolone acetate + 24 mg estradiol 17β. Subsequent ultrasound measurements and weights were taken on d 69, 101, and 133 of the trial. Cattle were harvested on d 165 or 195, based on target ultrasound BF (1.1 cm) and live weight maximum of 635 kg to prevent overweight (> 430.4 kg) carcasses. Implanting increased ($P < 0.001$) overall ADG by 21.4% (1.40 vs 1.70 kg/d). Feed efficiency, during the final 126 d of the trial, was improved ($P < 0.001$) by 8.3%. Rate of BF development did not differ ($P \geq 0.59$) between treatment, however, final BF was greater ($P = 0.05$) for implanted versus control steers. Implanting increased ($P < 0.01$) ultrasound REA and delayed ($P \leq 0.05$) %IMF development on d 69, 101, and 133. At harvest, implanted steers had larger ($P < 0.001$) REA (78.1 vs 85.0 cm²) and 17.5% lower ($P < 0.001$) marbling scores than controls. Implanting increased ($P < 0.001$) WBS force values by 13.3%. In conclusion, feedlot performance and muscle deposition can be improved with the use of implants without affecting BF accretion. However, %IMF was decreased by implanting, resulting in decreased marbling scores when cattle were harvested at similar BF. Therefore, real time ultrasound can be used in conjunction with implant programs to balance live cattle performance with carcass merit.

Key Words: Beef Cattle, Implants, Ultrasound

70 Relationship of behaviors and production measures between prepartum milked and non-prepartum milked first calf heifers. K. J. Daniels*¹, J. R. Townsend¹, S. S. Donkin¹, E. A. Pajor¹, S. D. Eicher², A. G. Fahey¹, and M. M. Schutz¹, ¹*Department of Animal Sciences, Purdue University,* ²*USDA-ARS LBRU, Purdue University.*

The objective of this study was to compare behaviors of prepartum milked (P) and control (C) heifers with a specific focus on feeding behaviors and their relationship with DMI and milk yield (MY). Twenty-two heifers approaching first calving and blocked by expected calving date, were randomly assigned to either the P or C treatment (trt) group. Heifers were housed in tiestalls from 28d prior to expected calving through 56d postpartum and provided feed for ad libitum consumption. The P heifers were milked twice daily beginning at 21 d before expected calving and C heifers were not milked until after calving. All heifers were videotaped 24 h/d, using time-lapse video recording, beginning 15d prior to expected calving through 14d after calving. On d -15, -6, -2, +2, +8 and +13 relative to actual calving, durations of standing (S), lying (L), feeding (F), ruminating (R) and ruminating while lying (RL) were measured. Daily MY and DMI were determined. Models for analyses included trt, d and their interaction, with trt and duration of behaviors as covariates for DMI and MY. The P heifers maintained higher MY from d1 through d14 ($P < .01$). Postpartum DMI, expressed as a percentage of body weight (DMI%), decreased less for P ($P < .01$) just prior to calving; and was greater for P through d14 ($P < .01$). For P and C, R ($P < .01$) differed across d and there were d by trt interactions for S ($P < .01$), L ($P < .01$), F ($P < .05$) and RL ($P < .05$). Heifers spending more time LR on d -6 ($P < .05$) and +2 ($P < .01$) or F on d -6 ($P < .05$) and -2 ($P < .05$) had greater MY on d 1 through 7. The MY was elevated on d 8 through 14 with increased time spent F on d +2 ($P < .05$) and +8 ($P < .05$), R on d +2 ($P < .01$) and LR on d -6 ($P < .01$) and -2 ($P < .05$). Postcalving DMI% from d 1 through 14 was positively associated with duration of LR on d -2 ($P < .05$). Duration of behaviors, MY and DMI differed for C and P, indicating that prepartum milking has an affect

on first calf heifers. The data indicate that behavioral changes and production responses of P heifers are related and that differences in DMI accompanied MY.

Key Words: Heifers, Behavior, Prepartum Milking

71 Potential to predict coupling of ammonia generation to ammonia uptake in the rumen. E. B. Venable* and M. S. Kerley, *University of Missouri-Columbia.*

A primary factor controlling efficiency of nitrogen (N) use by the ruminant is the capture of N by ruminal microflora. The hypothesis of this research was that ammonia-N release could be coupled to ammonia-N uptake via predictive equations. To test this hypothesis, a single-flow effluent continuous culture apparatus was used with 24 independent 1460 ml fermentors submerged in a 39degC water bath. Each fermentor was outfitted with ports to receive carbon dioxide and buffer. The fermentors were designed with openings to allow the addition of diet and to monitor pH. A liquid dilution rate of 4% was maintained. Rumen fluid and McDougalls buffer was used in a ratio of 4:1 to inoculate the fermentors. Six dietary treatments were designed to provide increasing rates of ammonia-N generation by combining soybean meal (SBM), corn gluten meal (CGM) and ground corn (GC) at the following ratios: diet 1) 100% GC, diet 2) 96.25% GC, 1.05% SBM, 2.7% CGM, diet 3) 92.5% GC, 2.1% SBM, 5.42% CGM, diet 4) 85% GC, 4.2% SBM, 10.8% CGM, diet 5) 70% GC, 8.3% SBM, 21.67% CGM, and diet 6) 40% GC, 16.7% SBM, 43.3% CGM. Diet four was designed to optimize ammonia-N generation with uptake based on predicted degradation and microbial efficiency (MOEFF). Each diet was ground to 2 mm for uniform particle size and fed 12 hours apart. An acclimation period of 7 days was allowed, followed by 3 days of sampling. Data were analyzed using the PROC GLM procedure of SAS. The ammonia generation rate did not influence ($P > 0.05$) organic matter digestibility. Ammonia concentration was increased ($P > 0.05$) when the ammonia-N generated was predicted to be greater than ammonia-N uptake. However, microbial-N flow and efficiency was improved when ammonia generated was predicted to be greater than ammonia-N uptake. This research demonstrated that coupling ammonia-N generation and uptake in the rumen can be predicted. However, further research is needed to determine if bacterial N response to higher than predicted ammonia uptake was due to increased amino acid or non amino acid N in the bacteria.

Key Words: Microbial Efficiency, Ammonia, Continuous Culture

72 Optimizing the use of distiller grain for dairy-beef production. C. B. Rincker*, L. L. Berger, and T. G. Nash, *University of Illinois.*

Optimizing the use of distiller grain (DG) is becoming increasingly important as ethanol production increases. Holstein steers (n=320, 190.8 ± 1.89 kg initial wt.) were allotted to one of 10 finishing diets with 8 steers/pen. Dietary treatments included dry and wet distillers grain (at 0, 12.5, 20, 25, 37.5, 50% of diet were offered ad libitum). After 112 days, 4 treatments were switched to represent the change from 20% to 37.5% and from 37.5% to 20% for both wet distiller grain (WDG) and dry distiller grain (DDG). Fecal samples were composited on a pen basis, subsampled, and analyzed for N, P, and S. Cattle were harvested after 270 d on feed. Orthogonal contrasts were performed for: control versus DG diets, DDG versus WDG, and diet change from 20 to 37.5% DG versus 37.5 to 20% DG. ADG, DMI, and feed efficiency (G:F) were evaluated for the growing period (112 d) and the entire trial (270 d). Steers had a significant linear decrease in ADG at 270 d with an increasing level of WDG ($P < 0.05$). Also, steers which shifted from high DG to (37.5%) low DG (20%) had lower ADG than steers switched from low DG (20%) to high DG (37.5%) ($P < 0.05$). There was a quadratic effect on DMI with increasing WDG ($P < 0.05$) with steers fed 25% WDG had the highest DMI. There was a linear increase in G:F as the level of DDG increased ($P < 0.05$). Steers had a quadratic response in G:F with WDG levels ($P < 0.05$) with the 50% WDG steers being the most efficient. Dairy-beef fed WDG diets were significantly more efficient when contrasted against those fed DDG diets ($P < 0.05$). Fecal P and S levels increased linearly with increasing DDG ($P < 0.05$) and quadratically with increasing WDG ($P < 0.05$). Steers fed DG had a higher dressing percent than control ($P < 0.05$) and no significant

differences among other carcass parameters. When DDG was priced at 110/ton and WDG 100/ton with 2.50/bushel corn, low levels (12.5 – 25%) were more profitable. When DDG were priced at 90/ton and WDG at 80/ton with 2.50/bushel corn, the 25–37.5% diets were more profitable.

Key Words: Dairy-Beef, Distillers Grain, Economics

73 Induction of endothelial cell migration: A proposed mechanism for vascular endothelial growth factor's (VEGF) action on neovascularization and seminiferous cord formation during testis morphogenesis. R. C. Bott*, D. T. Clopton, R. M. McFee, and A. S. Cupp, *University of Nebraska*.

In the embryonic testis, establishment of blood vessel networks (neovascularization) and cord formation are dependent on migration of endothelial and pre-peritubular cells from the adjacent mesonephros into the developing testis. VEGF and its receptor, VEGFR-2, are essential for neovascularization of many organs. Therefore, we hypothesized that VEGF induces migration of endothelial cells expressing VEGFR-2 from the mesonephros into the developing testis to establish vasculature and normal testis morphology. To test this hypothesis we conducted two experiments. First, we inhibited VEGF signaling in embryonic d 13 (E13) rat testis organ cultures (14 organ pairs) by treating with VEGFR-TKI (SuM). Treatment resulted in arrested vascular development (reduced tenfold when compared to controls; $P < 0.0001$) and impaired cord formation with a reduction in area (76% of controls; $P < 0.01$). In the second experiment, testes from E11 to E14 VEGFR-2/lac-Z mice were examined for VEGFR-2 protein expression by staining for β -galactosidase. At E11, VEGFR-2 was present in cells within the mesonephros with several cells staining blue throughout the developing testis. VEGFR-2 protein expression increased from E12 to E13 and was present throughout the interstitium surrounding developing seminiferous cords. By E14, all vasculature within the testis stained positively for VEGFR-2. Thus, VEGFR-2 was present in cells migrating from the mesonephros early in testis morphogenesis and in all vasculature after testis differentiation. The results of these experiments demonstrate that the signal transduction between VEGF and its receptor is essential for embryonic testis neovascularization and morphogenesis. We propose that VEGF regulates vascular development and seminiferous cord formation through induction of endothelial cell migration into the testis during morphogenesis.

Key Words: Testis Morphology, Neovascularization, VEGF

74 Effect of progestins on bovine satellite cell insulin-like growth factor-I and myogenin messenger RNA (mRNA) abundance. E. K. Sissom* and B. J. Johnson, *Kansas State University*.

Research has shown that progestins can elicit an anti-proliferative effect on cells through a non-genomic mechanism. These non-genomic mechanisms are classified as an action by which the progestin does not work through the typical pathway involving transcriptional regulation by the progesterone receptor. Previous results have shown the addition of melengestrol acetate (MGA), a synthetic progestin, to cultured bovine muscle satellite cells resulted in a dose-dependent decrease in DNA synthesis as measured by [3 H]-thymidine incorporation rate. Contrary to MGA, DNA synthesis was not altered by progesterone (P4) addition. The purpose of these experiments was to investigate the effects of MGA and P4 on insulin-like growth factor-I (IGF-I) and myogenin mRNA abundance in cultured, proliferating, bovine muscle satellite cells. Satellite cells were used to assess the effects of MGA and P4 (0 and 10 nM) on IGF-I and myogenin mRNA levels. Cells were plated in Dulbecco's Modified Eagle Medium containing 10% fetal bovine serum on tissue culture plates coated with reduced growth factor matrigel. The MGA or P4 was added directly onto cell cultures at 0 and 48 h after plating. At 72 h, total RNA was isolated from the cells and reverse transcribed for complementary DNA (cDNA) synthesis. Real-time quantitative-PCR was performed on the cDNA to estimate IGF-I and myogenin mRNA abundance. Melengestrol acetate addition (10 nM) increased (2.2-fold, $P < 0.05$) IGF-I mRNA abundance, but did not alter ($P > 0.05$) the level of myogenin mRNA. Cells treated with P4 (10 nM) had similar ($P > 0.05$) IGF-I mRNA levels, but myogenin mRNA abundance was increased (2.5-fold, $P < 0.05$). Even though MGA decreased proliferation in previous experiments, IGF-I mRNA abundance was increased in the presence of MGA. These results show that MGA and P4 may be

working through either a genomic or non-genomic mechanism to affect factors that impact both proliferation and differentiation.

Key Words: Melengestrol Acetate, Progesterone, Skeletal Muscle

75 Effect of field pea-based supplement on ruminal fermentation parameters in nursing calves grazing native range in western North Dakota. A. A. Gelvin*¹, G. P. Lardy¹, D. G. Landblom², and J. S. Caton¹, ¹*Department of Animal and Range Sciences, North Dakota State University*, ²*Dickinson Research and Extension Center*.

Eight Angus x Hereford nursing steer calves (145 \pm 27 kg initial BW), fitted with ruminal cannulas, were used to evaluate effects of field pea (*Pisum sativum*) based supplement (SUP) and advancing season on ruminal characteristics. Treatments were control (CON) and SUP (19.1% CP, DM basis) fed at 0.45% BW daily. Cows and calves grazed native range from late June through early November. Collection periods were 10 d in length and occurred in July, August, September, and October. Ruminal pH was lower ($P = 0.05$) in SUP and decreased linearly ($P = 0.01$) with season. Ruminal ammonia was greater ($P < 0.001$) in SUP, and ruminal ammonia changed quadratically ($P = 0.002$) with the greatest ammonia concentration occurring in August. Supplemented calves had greater ($P = 0.02$) total VFA concentration and decreased ($P = 0.01$) acetate and increased ($P \leq 0.03$) butyrate and valerate proportions. Supplemented calves had lower acetate:propionate ratio ($P = 0.06$). Total VFA concentration decreased linearly ($P = 0.007$) and acetate proportion increased linearly ($P = 0.05$) with advancing season. Rate of in situ forage DM and CP degradation decreased linearly ($P = 0.02$) with season and was not affected by SUP. Quadratic effects ($P < 0.01$) were present for rate of forage NDF and ADF in situ degradation with the highest rates in September. Rate of supplement DM degradation decreased linearly with advancing season ($P = 0.02$), while supplement CP degradation increased ($P = 0.008$) quadratically. No treatment or season effects were present for fluid passage rate, but ruminal volume increased linearly ($P < 0.001$) with season. Negative effects due to the use of field pea-based supplement were not evident for ruminal fermentation parameters measured. Further research should evaluate the effects of various proportions of field peas in supplement on ruminal fermentation in nursing calves.

Key Words: Nursing Calves, Ruminal Fermentation, Supplement

76 Dietary conjugated linoleic acid (CLA) affects the immune system of neonatal Holstein calves. K. I. Meek*¹, S. T. Franklin¹, L. J. Driedger¹, J. A. Jackson¹, M. W. Schilling², and M. T. Sands¹, ¹*University of Kentucky*, ²*Mississippi State University*.

Increased health status of several species has been attributed to diets supplemented with CLA. The objective of this study was to determine if CLA content of milk from cows fed to enhance CLA affects growth or the immune system of dairy calves. Holstein calves (n = 32) were removed from their dam at birth. Calves received 3.8 L of colostrum divided into two feedings after initial blood sampling and 12 h later. Calves were randomly assigned to treatments of low CLA (average of 0.9 g CLA/d) or high CLA (average of 2.9 g CLA/d) diets from whole milk fed at 3.8 L/d. Body weights (BW) were obtained at birth, and 3, 7, 14, 21, 28, 35, and 42 d of age. Blood samples were obtained via jugular veinipuncture at birth, 24 h, 3 d, and weekly through 42 d of age for analysis of serum protein concentrations (SPC), white blood cell (WBC) counts, and packed cell volumes (PCV). Leukocytes were isolated at birth, 3, 7, 14, 28 and 42 d and analyzed by flow cytometry to determine proportions of leukocyte subpopulations. Leukocyte membrane fatty acid content was evaluated at birth, 3, 7, 14 and 28 d. The amount of milk fed was converted to an energy corrected milk (ECM) basis. When corrected for energy content, calves fed low CLA milk received an equivalent of 4.3 kg ECM/d as compared to calves fed high CLA milk at 4.0 kg ECM/d. Low CLA treatment calves had greater ($P < 0.05$) SPC compared with the high CLA group. There were no effects of treatment on WBC counts or PCV. The high CLA treatment suppressed ($P < 0.05$) CD2+ T-cells in calves compared with the low CLA treatment. Leukocyte membrane CLA content was greater ($P < 0.0001$) for the high CLA treatment compared with the low CLA treatment and content increased ($P < 0.0001$) as calves aged with a treatment by age interaction ($P < 0.0001$). There was no effect ($P > 0.05$) of treatment on BW or average daily gain by week. Dietary CLA had no adverse

effects on growth or the immune system of neonatal calves. Treatment differences in leukocyte proportions and membrane CLA content may impact cellular response to disease challenge.

Key Words: CLA, calves, immune system

77 Effects of dietary high-linoleate safflower seeds on IGF-I in the hypothalamus, anterior pituitary gland, serum, liver, and follicular fluid of primiparous beef cattle. E. J. Scholljegerdes*, B. W. Hess, E. A. Van Kirk, and G. E. Moss, *University of Wyoming, Animal Science Department.*

Reproduction may be influenced by the IGF-I system. Therefore, our objectives were to evaluate the influence of supplemental high-linoleate safflower seeds on IGF-I concentrations in beef cows during early lactation. Beginning 1 d postpartum, primiparous, crossbred beef cows (initial BW = 410 ± 24.2 kg) were fed foxtail millet hay at 2.13% of BW and either a low-fat control supplement (61.2% corn, 32.1% safflower seed meal, 3.7% liquid molasses; Control) at 0.37% BW (n = 9) or a supplement containing 94% cracked high-linoleate (67% 18:2) safflower seeds and 6.0% liquid molasses (Linoleate) at 0.24% of BW (n = 9). Supplements were formulated to be isonitrogenous and isocaloric and the Linoleate diet was formulated to contain 5% fat. Starting 3 d postpartum, cattle were bled every 3 d for collection of serum and subsequent analysis of IGF-I concentration. Cattle were slaughtered after 35 d for collection of hypothalamic, anterior pituitary glands, livers, and ovarian follicular fluid for analysis of IGF-I concentration. Ovarian follicular fluid IGF-I concentration was determined in each of three follicular size classifications (Class 1 = 3 to 5 mm; Class 2 = 6 to 9 mm; Class 3 = 10 to 15 mm). Dietary treatment did not affect IGF-I concentrations in the liver ($P = 0.15$), stalk median eminence ($P = 0.94$), or anterior pituitary gland ($P = 0.33$). Concentrations of IGF-I in serum and median basal hypothalamus were greater ($P \leq 0.05$), and tended ($P = 0.06$) to be greater in the preoptic area of the hypothalamus for Control than Linoleate. Control had greater ($P \leq 0.03$) IGF-I in fluid of all three follicular size classes compared to Linoleate; however, no differences ($P = 0.87$) were noted between classifications within either treatment. In conclusion, supplemental high-linoleate safflower seeds may have negative effects on reproduction due to reduced IGF-I concentration in tissues that are essential to reproductive processes.

Key Words: Beef Cattle, IGF-I, Lipid Supplementation

78 Effect of nutrition and pregnancy on intestinal tissue mass and cellularity in gestating adolescent ewes. J. J. Reed*¹, J. S. Caton¹, D. A. Redmer¹, L. P. Reynolds¹, J. S. Milne², R. P. Aitken², and J. M. Wallace², ¹*Department of Animal and Range Sciences, North Dakota State University,* ²*Rowett Research Institute, Scotland.*

Adolescent ewes were used in a 2 x 3 factorial design to test effects of plane of nutrition and pregnancy on maternal intestinal growth and cellular proliferation. Singleton pregnancies to a single sire were established by embryo transfer and thereafter ewes were offered a moderate (M) or high (H) level of a complete diet (2.4 Mcal/kg and 14% CP) to promote slow or rapid maternal growth rates. After d 90 of pregnancy, feed intake of the M group was adjusted weekly to maintain BCS and meet the increasing nutrient demands. Ewes were slaughtered at either 50 (n = 6M, 5H), 90 (n = 8M, 6H), or 130 (n = 8M, 6H) d of pregnancy. Jejunal samples were frozen for subsequent determination of protein, RNA and DNA. Maternal BW (live BW - gravid uterus) for M ewes was similar ($P = 0.85$) at d 50 and 90 and increased ($P < 0.06$) from d 90 to 130 (35.3, 35.8, and 40.2, respectively), whereas maternal BW increased ($P \leq 0.006$) throughout pregnancy in H ewes (46.7, 54.6, and 62.8, respectively). Jejunum mass (g/kg maternal BW) was greater ($P = 0.003$) in M than in H ewes and tended to decrease ($P = 0.11$) from d 50 to 130 in both treatments. Ileum mass (g/kg maternal BW) in M ewes was less than ($P = 0.07$) H ewes at d 50, was equal to ($P = 0.19$) H ewes at d 90, and was greater than ($P = 0.02$) H ewes at d 130. Small intestine mass (g/kg maternal BW) was similar ($P \geq 0.21$) between M and H ewes at d 50 and 90, but M ewes had greater ($P = 0.001$) mass at d 130. Jejunal RNA and protein concentrations were lower ($P \leq 0.07$) and DNA concentrations unaffected ($P = 0.43$) in M vs H ewes. Pregnancy did not affect ($P \geq 0.23$) jejunal RNA, DNA, or protein concentrations. Jejunal cellular proliferation was not affected ($P \geq 0.50$) by treatment or pregnancy. Data indicate that intestinal mass

as a proportion of maternal BW declines in over nourished gestating ewe lambs. This response is more pronounced during late gestation and is likely explained by increasing maternal BW and not changing cellularity or proliferation.

Key Words: Nutrition, Pregnancy, Intestinal Growth

79 Pharmacological zinc supplementation in nursery pigs regulates glyoxalase 1 and peroxiredoxin 4 gene expression. M. M. Martínez*, G. M. Hill, N. E. Raney, J. E. Link, and C. W. Ernst, *Michigan State University.*

The U.S. swine industry's use of pharmacological zinc (Zn) as a health and growth promoter for newly weaned pigs is well documented. However, the mechanism of action of pharmacological Zn has not been elucidated. We hypothesize that the beneficial effects of pharmacological Zn occur, at least in part, through effects on gene expression regulation. Therefore, the goal of this study was to determine if differentially expressed genes could be detected using the differential display reverse transcription polymerase chain reaction (DDRT-PCR). Twenty-four pigs (5.5 kg, 21 d) were fed adequate Zn (150 ppm) or one of two pharmacological concentrations (1,000 ppm; 2,000 ppm) as zinc oxide. Pigs were killed after 14 d of dietary intervention, and liver was collected for total RNA isolation. For DDRT-PCR, the RNA was DNAase treated and reverse transcribed using a 3' poly-T primer ending in the anchor bases AC. The RT products were labeled with ³³P-dATP and amplified with the 3' anchor primer and six 5' arbitrary primers. A total of 52 amplicons were putatively identified as differentially expressed, cloned and sequenced. Two transcripts exhibiting induced expression in pigs fed pharmacological Zn had sequence homologies to genes encoding glyoxalase 1 (GLO1) and peroxiredoxin 4 (PRDX4). These proteins are antioxidant enzymes involved in the conversion of methylglyoxal into lactate by proton transfer, and in the reduction of peroxides, respectively. Real time RT-PCR was used to confirm the DDRT-PCR results. Preliminary real time data confirmed that pigs fed 1,000 ppm Zn had higher GLO1 mRNA abundance ($P < 0.03$) when compared to pigs fed 150 or 2,000 ppm Zn. In addition, pigs fed 1,000 ppm Zn demonstrated a trend to an upregulation of PRDX4 ($P = 0.07$) when compared to pigs fed 2,000 ppm Zn. Results suggest that feeding pharmacological Zn (1,000 or 2,000 ppm) may affect oxidation-reduction pathways that are essential for cell detoxification and proper cell function.

Key Words: Gene Expression, Pharmacological Zinc, Pigs

80 Potential for empirical equations based on dilution rate to predict microbial efficiency and amino acid flow to the duodenum. A. L. Mueller*¹, M. R. Ellersieck², and M. S. Kerley¹, ¹*Department of Animal Science, University of Missouri-Columbia,* ²*Agriculture Experimental Station-Statistics, University of Missouri-Columbia.*

To accurately determine dietary AA needs of a ruminant, the microbial AA contribution to duodenal flow must be estimated. The Beef NRC (2000) predicts microbial efficiency (MOEFF) and the resulting AA flow based on the maintenance rate of the rumen bacteria, the theoretical maximum yield of the rumen bacteria adjusted for effective NDF, and the digestion rate of the feedstuffs. Previous research had shown that MOEFF was a function of microbial growth rate, with the latter being a function of dilution rate (DR). Therefore, we hypothesized that DR could be used to estimate microbial N and AA yields from the rumen. The objective of this study was to determine if substrate specific equations based on DR could more accurately predict MOEFF, microbial N and essential amino acid (EAA) flows to the duodenum than the Beef NRC model. Data from 27 published studies (70 diets) were used to evaluate the effectiveness of equations based on DR to predict MOEFF and the flow of microbial N and EAA to the duodenum. The MOEFF equations in the Beef NRC model were replaced with DR-based equations to create two models. A substrate specific (SS) model used the experimentally determined DR to calculate MOEFF and a combination (COMB) model used the NRC-predicted DR to calculate MOEFF. The SS, NRC, and COMB predicted MOEFF, microbial N and EAA flows to the duodenum were compared to measured flows. The SS predicted MOEFF and microbial N flow similar ($P > 0.05$) to measured values. The COMB predicted microbial EAA flows similar ($P > 0.05$) to measured values. The NRC significantly ($P < 0.05$) over predicted

MOEFF, microbial N and EAA flows compared to measured values. Dilution rate based equations were more accurate and precise in predicting MOEFF, microbial N and EAA flows to the duodenum than the Beef NRC model. Being able to use the NRC-predicted DR in the DR-based equation would allow for the inclusion of these equations into the NRC model. Accurate prediction of microbial EAA flows would allow for improved ration formulation and supplementation of limiting EAA without overfeeding CP.

Key Words: Modeling, Microbial Efficiency, Dilution rate

81 Vaccination as an intervention strategy to reduce the prevalence of *Escherichia coli* O157:H7 in feedlot cattle. R. E. Peterson*, D. R. Smith, R. A. Moxley, T. J. Klopfenstein, G. E. Erickson, and S. Hinkley, *University of Nebraska*.

A clinical trial was conducted to test the effect of vaccinating feedlot cattle against Type III secretory proteins of enterohemorrhagic *Escherichia coli* on the proportion of feedlot steers shedding *E. coli* O157:H7 in feces. Medium-weight steers (N=480) were assigned randomly to 60 pens (8 hd/pen) and to one of four vaccination treatments (2 hd/trt) within pen. Treatments included: 1) no vaccination; 2) vaccinated once at re-implant (d 42); 3) vaccinated upon arrival (d 0) and again at re-implant (d 42); and 4) vaccinated on arrival (d 0), at d 21, and again at re-implant (d 42). An additional 128 steers were assigned to 12 pens within the same feedyard to serve as unvaccinated external controls. Each steer was sampled every three weeks of the feeding period for 1 pre-treatment period (d 0), 2 interim periods (d 21, d 42), and 4 test-period samplings (d 63, d 84, d 105, d 126). From May 8 to September 26 2003, 4260 individual fecal samples were collected from 608 calves. The odds for a treated animal to shed O157 was compared to that of unvaccinated control cattle within the pen and control cattle in the external pens, accounting for repeated measures, block, and pen. Pre-treatment prevalence of O157 in the 60 treatment pens averaged 45% and did not differ ($P>0.10$) between treatment groups. Initial mean prevalence of the external control pens (30.5%) was lower ($P<0.05$) than vaccinated pens (45%). Vaccine efficacy of receiving 1, 2, or 3 doses of vaccine was 52, 58, and 68% respectively ($P<0.01$), compared with cattle in pens not receiving vaccine. Unvaccinated cattle in treated pens were 50% less likely to shed O157 than cattle in pens not receiving vaccine ($P=0.02$). We concluded that vaccination effectively reduced the proportion of feedlot cattle shedding O157 in the feces, that the effect was dose-responsive, and that vaccination within a pen conferred protection to unvaccinated pen-mates (herd-immunity).

Key Words: Cattle, *Escherichia coli*, Vaccination

82 Feeding L-carnitine to gestating sows alters the insulin-like growth factor system in cultured porcine embryonic myoblasts isolated from fetal skeletal muscle. A. T. Waylan*¹, B. J. Johnson¹, D. P. Gnad¹, and J. C. Woodworth², ¹*Kansas State University*, ²*Lonza Inc*.

L-Carnitine supplementation has been shown to affect the IGF system in several species. The IGF system affects fetal muscle growth and development. Our objective was to determine the effects of L-carnitine on cell proliferation and growth factor messenger RNA (mRNA) levels in cultured porcine embryonic myoblasts (PEM) isolated from fetuses at mid-gestation from sows fed a common gestation diet with either a 50 g top dress of 0 (control, n= 6) or 100 mg L-carnitine (n=6). Proliferation of PEM was evaluated at 36, 48, 60, and 72 h post-plating. Real-time quantitative-PCR was used to determine growth factor and myogenin mRNA levels in cultures at 96 h post-plating. Treatment did not affect ($P>0.05$) number of cells/cm², but the number of cells/cm² increased ($P<0.01$) between each time period. There was a treatment x time interaction ($P=0.05$) for number of doublings. The number of doublings was greater ($P<0.01$) between 36 and 48 h for PEM isolated from dams fed L-carnitine compared to controls. When PEM, isolated from a commercial gilt, were incubated with L-carnitine (n=4) at six concentrations (3.125, 6.25, 12.5, 25, 50, and 100 μ M) and compared to a control, no proliferation differences were detected ($P>0.05$), indicating L-carnitine's action for increased muscle cell proliferation is regulated through an indirect mechanism. There was no treatment difference ($P>0.05$) for IGF-I or IGFBP-5 mRNA levels. However, PEM isolated from sows fed L-carnitine had decreased ($P<0.05$) IGF-II, IGFBP-3, and myogenin (61, 59, 67%, respectively) mRNA levels compared to controls.

The IGF-II and myogenin data suggest that there is a delay in the onset of terminal differentiation in PEM isolated from sows fed L-carnitine. This could be due to prolonged proliferation of these cells because of the numerical increase in IGF-I mRNA. These data suggest L-carnitine influences the IGF system and myogenin resulting in enhanced proliferation and delayed differentiation of PEM.

Key Words: IGF, L-Carnitine, Pigs

83 Molecular ecological analysis of porcine ileal microbiota responses to antimicrobial growth promoters. C. T. Collier*¹, M. Smiricky-Tjardes¹, B. Deplancke¹, D. B. Anderson², and H. R. Gaskins¹, ¹*University of Illinois*, ²*Elanco Animal Health, Research and Development*.

Cultivation-independent microbial molecular ecology approaches were used to examine the effects of antibiotic growth promoters on the pig ileal microbiota. Five-week-old barrows were fitted with a simple T-cannula at the distal ileum. Three diets (n=5/diet) were fed for 5 weeks and supplemented as follows: negative control; continuous tylosin administration; and an antibiotic rotation sequence (week 1, chlorotetracycline sulfathiazole penicillin; week 2, bacitracin and roxarsone; week 3, lincomycin; week 4, carbadox; week 5, virginiamycin). Ileal luminal contents were collected for DNA isolation at the end of each of the 5 weeks. PCR amplified V3 16S rDNA was analyzed via denaturing gradient gel electrophoresis (DGGE) and quantitative polymerase chain reaction (qPCR). Resulting PCR-DGGE band numbers (bacterial species) were counted and the banding patterns analyzed by Sorenson's pairwise similarity coefficients (Cs). Band numbers and total bacterial DNA concentrations decreased ($P < 0.05$) temporally in antibiotic-treated pigs compared to controls. Comparisons of inter-group Cs indices, indicate treatment-dependent alterations in banding patterns, while intra-treatment comparisons revealed increased homogeneity in antibiotic-treated versus control pigs. Sequence analysis of treatment-specific bands identified three Lactobacilli, one Streptococcus, and one Bacillus species that were diminished with antibiotic rotation treatment, while tylosin selected for the presence of *L. gasseri*. Qualitative PCR revealed that total bacteria were decreased ($P < 0.05$) by tylosin and rotation treatments, while the percentage of lactobacilli increased ($P < 0.05$) at d 14 through d 28 in tylosin-treated pigs. The reduction in total bacteria by antibiotics may reduce host-related intestinal or immune responses, which divert energy that could otherwise be used for growth. Conversely, the ability of tylosin to enhance animal growth may relate to its apparent selection for *L. gasseri*, a commensal known to competitively exclude potentially pathogenic species from colonizing the intestine.

Key Words: 16S rDNA PCR, Antibiotics, Pig

84 Ankyrin repeat and SOCS box protein (ASB) 15 increases fiber area in gastrocnemius and soleus muscles of mice. T. G. McDaneld*, K. M. Hannon, and D. E. Moody, *Purdue University*.

Ankyrin repeat and SOCS box protein (ASB) 15 belongs to a family of genes characterized by the presence of both ankyrin repeat and SOCS (suppressor of cytokine signaling) box motifs. Previously, we have shown that ASB15 mRNA is down-regulated in skeletal muscle in response to beta adrenergic receptor agonists. The objective of this research was to test the hypothesis that exogenous expression of ASB15 in skeletal muscle would decrease muscle growth and attenuate the anabolic effect of clenbuterol. Gastrocnemius and soleus muscles of the right hindlimb of 6-wk-old mice were injected with expression vectors containing a cytoplasmic β -galactosidase (β -gal) reporter gene and ASB15. The contralateral limb of each mouse received only the β -gal reporter construct. A series of electrical pulses were delivered across the hindlimb to facilitate uptake of the vectors into muscle fibers. Mice were randomly assigned to either control or clenbuterol (1mg/kg) treatment groups. Intraperitoneal administration of clenbuterol or control treatments started on day 2 after electroporation and continued for seven days. Gastrocnemius and soleus muscles were removed from each mouse, weighed, and analyzed via histochemistry to measure muscle fiber area. Muscle fiber area was significantly greater in muscles that received ASB15 plus β -gal compared to muscles that received β -gal alone ($P < 0.01$). While clenbuterol treatment increased body weight gain and gastrocnemius and

soleus muscle weight of the mice ($P < 0.05$), there was no effect of clenbuterol on muscle fiber area ($P > 0.05$). However, there was a trend for a clenbuterol by ASB15 interaction in that the effect of ASB15 on muscle fiber area was less for clenbuterol treated mice compared to control mice ($P = 0.086$). In conclusion, expression of ASB15 in muscle fibers increases muscle fiber area while clenbuterol did not completely block this effect of ASB15. Still, administration of clenbuterol increased body weight gain and muscle weight regardless of ASB15 expression.

Key Words: Anabolic, Muscle Growth, Skeletal Muscle

85 Estimate of infectious dose₅₀ in young pigs orally exposed to PRRS virus. J. Hermann^{*1}, M. Roof², K. Burkhardt², R. Evans¹, and J. Zimmerman¹, ¹Iowa State University, ²Boehringer Ingelheim.

Prevention and control of PRRS virus requires an understanding of transmission in the field. Current reports in the literature suggest that swine are susceptible to PRRS virus by several exposure routes, including intranasal, intramuscular, and oral. The minimum infectious dose

by either intranasal or intramuscular routes is known to be very low. Infection of swine via oral exposure has been reported, but the minimum infectious dose has not been estimated. Thus, data on the specific exposure dose necessary for infection is needed to assess the likelihood of transmission by oral exposure in the field. This study was designed to estimate the probability that a specific oral dose of PRRS virus would result in infection. The experiment was conducted as a randomized block design in which individually housed 19 - 24 day old pigs were orally exposed to a specific dose (titer) of PRRS virus (2 to 7 logs TCID₅₀). Each replicate consisted of 10 animals: 4 treatment levels of PRRS virus (run in duplicate), plus positive and negative control animals. To test a volume effect, treatment doses were administered in either 10 ml or 100 ml volumes. Animals were bled on days -7, 0, 7, 14, and 21 and serum samples tested for evidence of PRRS virus infection by virological and serological assays to determine whether exposure resulted in infection. Preliminary data suggests that an oral treatment dose of 10³ TCID₅₀ may be sufficient cause infection in young swine.

Key Words: PRRS Virus, Swine, Transmission

Growth, Development, Muscle Biology, Meat Science

86 Performance response of newly weaned pigs to differing zone-heating options in a wean-to-finish facility. R. Stowell, S. Colgan^{*}, and M. Brumm, *University of Nebraska*.

An experiment was conducted to assess the effects of zone-heating systems used in wean-to-finish facilities on temperatures in and around the resting area and on pig performance. The experimental treatments, arranged in a 2x2 factorial design, were source of zone heat [gas-fired brooder (GF) vs. 250 W heat lamp (HL)] and type of floor mat [wood sheathing (WS) vs. unheated rubber (UR)]. Each treatment combination was replicated 4 times in 16 total pens within a fully slatted, naturally ventilated facility. Each 2.4 m x 4.3 m pen was stocked with 15 newly weaned pigs (0.7 sq. m per pig, 17 days old, 5.2 kg initial weight) in March 2003. Data was collected over the next 26 days, during which zone heat was continuously available. The duration of data collection was limited by an outbreak of PRRS. No consistent differences in air temperature near the resting area (mat) were found between treatments. However, black-globe temperatures, measured 60 cm above the floor, were consistently about 1 C warmer ($P < 0.05$) in pens having gas-fired heaters or mats made of wood sheathing than in comparison pens. A heater x mat interaction was also observed ($P < 0.05$). Average daily gain was greater ($P < 0.05$) for pigs on wood sheathing than on rubber mats (245 vs. 232 g/d) and pigs were heavier after 26 days for WS vs. UR (11.5 vs. 11.2 kg, $P < 0.05$). Average daily feed intake (0.345 vs. 0.327 g/d) and feed efficiency ($G/F = 0.714$ vs. 0.709) were not different for WS and UR, respectively. No differences in pig performance existed ($P > 0.1$) between heating systems (GF vs. HL) over the 26-day study period. These data suggest that use of wood sheathing (oriented-strand board, 9.5 mm thickness) may result in slight improvements in performance of newly weaned pigs during the initial weeks in a fully slatted wean-to-finish facility.

Key Words: Zone Heat, Floor Mat, Pig Performance

87 Muscle glycolytic potential and blood parameters in pigs submitted to fasting and handling of different intensities. T. M. Bertol^{1,2}, M. Ellis¹, M. J. Ritter^{*1}, and F. K. McKeith¹, ¹University of Illinois, ²CNPq and Embrapa Suínos e Aves, Brasil.

This study was carried out to evaluate the effect of feed withdrawal and handling intensity on physiological and metabolic responses to handling and muscle glycolytic potential in pigs. Crossbred pigs ($n = 60$; BW = 107.7 ± 3.09 kg) were used in a randomized complete block design with a 2 x 2 factorial arrangement of treatments: 1) Fasting: 0 vs. 24 h; 2) Handling intensity: low vs. high. The handling procedure consisted of moving pigs through a passage (12.2 m long 0.91 m wide) 16 times. High intensity handling involved moving pigs rapidly with the use of an electric goad. Low intensity handling involved moving pigs at their own pace with the use of livestock panel and paddle. Biopsy samples were collected from the *longissimus* muscle at the beginning of fasting and immediately after and four hours after the handling procedure. Blood samples were collected two hours before and immediately after

the handling procedure. There were no interactions ($P > 0.05$) between fasting and handling intensity. Fasted pigs had lower ($P < 0.05$) baseline and post-handling body temperature (101.9 vs. 101.5; SEM = 0.11 and 103.5 vs. 102.9 degF; SEM = 0.13, respectively) and lower ($P < 0.05$) baseline PO₂ and PCO₂ than fed pigs. High intensity handling resulted in higher ($P < 0.05$) post-handling blood lactate and lower ($P < 0.01$) post-handling blood pH, HCO₃⁻, base excess, and TCO₂ than low intensity handling. Muscle glycolytic potential immediately after and four hours after the handling procedure (177.4 vs. 138.0; SEM = 6.47 and 168.1 vs. 142.0 μmol/g; SEM = 6.95, respectively) was lower ($P < 0.01$) in fasted than in fed pigs. In conclusion, fasting for 24 h did not attenuate the blood acid-base changes induced by handling. The combination of fasting and intense handling resulted in a reduction of muscle glycolytic potential.

Key Words: Acid-Base Balance, Fasting, Glycolytic Potential

88 Meat and carcass quality in pigs fed diets with differing energy sources. T. M. Bertol^{1,2}, M. Ellis¹, D. V. Brana^{*1,3}, M. J. Ritter¹, and F. K. McKeith¹, ¹University of Illinois, ²CNPq and Embrapa Suínos e Aves, Brasil, ³INIFAP-CONACYT, Mexico.

This study was carried out to evaluate the effect of dietary energy source on pork quality. Crossbred pigs (24 barrows, 24 gilts; BW = 93.9 ± 4.30 kg) were used in a completely randomized design with a 3 x 2 factorial arrangement of treatments: 1) Diet: control, high fat (HF; 10% supplemental fat), and high fat-low digestible carbohydrates (HF-LDC; 10% supplemental fat and 20% total starch); 2) Sex: barrows and gilts. The experimental diets varied in energy level but had the same lysine:energy ratio and were fed for 54 d. Pigs were harvested and meat and carcass quality evaluated. Carcasses from pigs fed control and HF diets were heavier (107.2^a, 110.0^a, 95.5^b kg, SEM = 1.84 for control, HF, and HF-LDC, respectively) and had higher dressing percentage (77.7^a, 76.6^a, 74.9^b %; SEM = 0.54) than carcasses from pigs fed HF-LDC diet ($P < 0.01$). Pigs fed HF diet had longer carcasses and higher backfat than pigs fed control and HF-LDC diets ($P < 0.05$). Barrows had higher ($P < 0.05$) first and tenth rib backfat than gilts. Subjective marbling (2.08, 2.12, 1.92; SEM = 0.183) and firmness (2.67, 2.58, 2.25; SEM = 0.262), pH₂₄ (5.49, 5.48, 5.45; SEM = 0.020), Minolta L#42# (49.4, 49.6, 49.3; SEM = 1.33), a#42# (8.0, 7.4, 7.5; SEM = 0.39), and b#42# (5.4, 5.1, 5.2; SEM = 0.47) values, drip loss (3.95, 3.34, 3.43%; SEM = 0.581), cooking loss (23.0, 25.0, 25.6%; SEM = 1.35), and shear force (3.34, 3.64, 3.48 kg; SEM = 0.192) were not affected ($P > 0.05$) by diet or sex. In conclusion, feeding diets with high fat in combination with low or normal levels of digestible carbohydrates to finishing pigs did not affect meat quality.

Key Words: Energy Source, Meat Quality, Pigs

89 Muscle glycolytic potential and blood responses to fasting in pigs fed diets with differing energy sources. T. M. Bertol^{1,2}, M. Ellis¹, D. V. Brana^{*1,3}, M. J. Ritter¹, and F. K. McKeith¹, ¹University of Illinois, ²CNPq and Embrapa Suínos e Aves, ³INIFAP-CONACYT, Mexico.

The study was carried out to evaluate the effects of dietary energy source and fasting on muscle glycolytic potential (GP) and blood responses to handling. Crossbred pigs ($n=96$; 48 barrows, 48 gilts; 94.7 ± 4.11 kg) were used in a randomized complete block design with a $4 \times 2 \times 2$ factorial arrangement of treatments: 1) Diet: control vs. high fat (HF; 10% supplemental fat) vs. low digestible carbohydrate (LDC; 20% total starch), vs. high fat-low digestible carbohydrate (HF-LDC; 10% supplemental fat, 20% total starch); 2) Fasting: 0 vs. 36 h; 3) Sex: barrows vs. gilts. The experimental diets were fed for 4 weeks, after which half of the pigs were fasted for 36 h. Pigs were submitted to a standard handling procedure, which consisted of moving them through a passage (12.2 m long x 0.91 m wide) for 8 laps, stimulated using an electric goad. Rectal temperatures were lower for fasted barrows ($P < 0.01$) for baseline (102.0^a , 101.3^c , 101.7^b , 101.7^b degF, SEM= 0.11 for barrows/fed, barrows/fasted, gilts/fed, and gilts/fasted, respectively) and post-handling (104.7^a , 103.7^c , 104.2^{ab} , 104.3^{ab} ; 0.17) measurements. Diet, fasting, and sex did not affect ($P > 0.05$) blood acid-base parameters. Muscle GP was lower ($P < 0.05$) in pigs fed HF diet at the beginning of fasting (210.3^a , 207.1^a , 183.2^b , 201.2^{ab} $\mu\text{mol/g}$, SEM=6.27 for control, LDC, HF, and HF-LDC, respectively) and also 4 h post-handling (179.3^a , 183.0^a , 152.7^b , 180.5^a ; 7.43). Fasted pigs had lower ($P < 0.05$) GP levels immediately (168.6 vs. 151.2 ; 5.12) and 4 h (182.3 vs. 165.5 ; 5.26) post-handling, and higher ($P < 0.01$) depletion of muscle GP during handling (-29.8 vs. -49.8 ; SEM= 4.92) than fed pigs. Dietary energy source and fasting did not affect blood acid-base responses to handling. High fat diets reduced muscle GP and increased the GP depletion induced by fasting and handling. Fasting induced a reduction of muscle GP.

Key Words: Energy Source, Fasting, Glycolytic Potential

90 Impact of castration time and method on performance, carcass, and tenderness values in steers. K. W. Bruns* and R. H. Pritchard, South Dakota State University.

Angus and Angus x Limousin steers from one ranch were used to evaluate the effect of castration time and method on production and carcass traits. At 2 mo of age, calves were randomly assigned to one of two treatments (TRT); surgical castration at 2 mo age (SC) or castrated at 9 mo age (375 kg) by banding (BAND). Calves assigned to SC received a Synovex-C implant at castration. All calves were weaned at 5 mo of age with no difference in weaning weight (SC = 223 vs BAND 222 kg; $P > 0.15$). Calves were blocked into heavy and light groups with a targeted gain of 1.1 kg/d on a 1.00 Mcal NE_G/kg diet fed for 91 d (heavy group) and 119 d (light group). A Magnum implant was administered to SC only, 29 d post weaning. No differences were observed between treatments for BW, DMI, ADG, or G/F during backgrounding. At the time of banding, BW was 375 kg for both treatments, SC and BAND. During the 29 d post-banding period, BAND caused reduced ($P < 0.05$) ADG (1.09 vs .59 kg) and G/F (122 vs 64 g/kg) while DMI (8.53 vs 8.26 kg) was unaffected. At the start of the finishing phase (30 d post-banding) a Revalor-S was administered to all steers. From this point until harvest, cumulative performance (117 d) did not differ between treatment for ADG, 1.5 vs 1.6 kg; DMI, 10.1 vs 9.9 kg; or G/F 154 vs 159 g/kg; however, an advantage in body weight was maintained at harvest for SC vs BAND (588 vs 577 kg; $P < 0.05$). Banded bulls tended to have less 12th rib fat (1.13 vs. 1.05 cm; $P < 0.15$) and had lower Yield Grade (3.0 vs 2.7; $P < 0.05$). Quality Grade (Small⁶³ vs Small⁵⁷) and Warner Bratzler Shear Force (3.2 vs 3.0 kg) were not affected by treatment. These results indicate that similar performance can be achieved during the suckling and background phases between steers and bulls when an appropriate implant strategy is used on the steer calves. Banding as a method of castration reduced gain 29 d post-banding, resulting in surgically castrated calves at 2 mo of age maintaining a weight advantage throughout the finishing period.

Key Words: Bulls, Castration, Tenderness

91 Analysis of pig growth from birth to sixty-one days of age. A. P. Schinckel*¹, J. Ferrel², M. E. Einstein¹, S. M. Pearce³, and R. D. Boyd³, ¹Department of Animal Sciences, Purdue University, ²Primary Nutrition, ³PIC USA.

Alternative versions of common nonlinear growth functions were evaluated on 433 pigs (220 gilts and 213 barrows) from birth to 61 d of age. The objective was to identify the function which best fit the BW data and reproduce the nonlinear relationships amongst the serial BWs. Two approaches were compared. The data were fitted to (1) mixed model random effects nonlinear models (SAS NLMIXED); and (2) each pig's individual data were fit to each function. Pigs were weighed at birth, weaning (19 d of age; SD = 2.4 d), 19 d postweaning, and 42 d postweaning. The model with the best fit was: $BW = \exp [(b_0 + b_1 (\text{Age} + 35) + b_2 (\text{Age} + 35)^2)]$, which was fit each individual pig's BW data. Although the function resulted in the smallest residual standard deviation (RSD) (0.336 kg), it did not predict birth weight ($R = 0.65$) as precisely as it predicted weaning BW and later BW ($R = 0.96$ to 0.99). In addition, the RSD was different at the four weigh dates and ranged from 0.04 to 0.45 kg. Birth BW had a linear-quadratic relationship with subsequent BW. Increasing birth BW of pigs with lighter birth BW had a much greater impact on increasing subsequent BW than increasing birth BW of the heaviest pigs. In addition, BW taken at 19 and 42 d postweaning had linear-quadratic relationships with weaning BW. The linear-quadratic relationships between the actual BW were predicted by fitting the exponential function to each pig's BW data. The relationships amongst the b_0 , b_1 , and b_2 values of the pigs were nonlinear and complex making stochastic modeling of BW from birth to 61 d of age difficult. Pigs with the lowest birth BW, 20th percentile or lower, had lower ADG, both at the same age and BW than pigs with greater birth BW. The results indicate that increasing the BW of the lightest birth BW pigs could increase the mean and decrease the variance in BW at subsequent ages.

Key Words: Pigs, Birth Weight, Growth

92 Using a stochastic model to optimize ractopamine (Paylean®) initiation time. N. Li¹, A. P. Schinckel*², P. V. Preckel¹, and B. T. Richert², ¹Department of Agricultural Economics, Purdue University, ²Department of Animal Sciences, Purdue University.

When to start feeding Paylean to late finishing pigs is an important management decision for pig producers. A stochastic model was employed to investigate the optimal return and management under alternative Paylean initiation ages for a 1,000 head gilt finishing facility. To estimate the loss of non-optimal Paylean starting age induced by visual inspection error, sensitivity analysis of return with respect to non-optimal Paylean starting age was performed at days around the optimal values. The model was used to optimize the return and management for alternative Paylean onset ages under a payment scheme that simulates a carcass merit payment system with a 2:1 ratio of the value dissected lean to fat tissue. The net returns were maximized when Paylean was fed for an average of 28 d. The model restricted Paylean to be fed either earlier or later than the optimal onset age, as well as fixed the Paylean concentration at 6.5 ppm, while leaving the dietary lysine concentration in each diet, time to switch to diets while Paylean is fed, and marketing management to be optimized. The results indicated that the further away from the optimal Paylean onset age, the less financial return was obtained. The annual lost opportunity income of delaying Paylean onset by 7 d was 623/barn/year, and 2,672 for a 14 d delay. The annual potential lost income from starting Paylean feeding by 7 d and 14 d early was 452 and 748/barn/year. The curve of annual losses versus the numbers of days off the optimal Paylean starting age resembles a quadratic function, but was non-symmetric with respect to zero value. The magnitude of the loss suggested that the acceptable window for Paylean onset was around 14 days, 7 d ahead of optimal and 7 d behind. The optimal time to start Paylean is an important factor in influencing the return to the swine facility and the use of the Paylean technology.

Key Words: Ractopamine, Pig, Management

93 Effect of removing different proportions of slaughter weight pigs from mixed-sex pens on subsequent growth performance of finishing pigs. J.M. DeDecker*, M. Ellis, M.E. Kocher, B.A. Peterson, M.J. Ritter, and S.E. Curtis, *University of Illinois*.

The objective of this study was to determine the effect of removing differing proportions of animals from mixed-sex pens on the subsequent growth performance of finishing pigs. Pens (n=40) of crossbred pigs (n=1040) were used in a randomized complete block design to evaluate four pig removal treatments: 1) 0% of pigs removed [Control], 2) 15% removed, 3) 30% removed, and 4) 45% removed. Pens (26 pigs/pen; mean BW=104.6 ± 0.53kg) were randomly allocated to treatment, and the heaviest animals were removed as dictated by treatment. Floor and feeder spaces/pig were 0.66m² and 2.3cm, 0.78m² and 2.8cm, 0.95m² and 3.4cm, and 1.22m² and 4.4cm for the 0, 15, 30, and 45% removal treatments, respectively. Growth performance over the 22-d study period for the entire group of pigs after removal (26 vs 22 vs 18 vs 14 pigs/pen for the 0, 15, 30, and 45% removal treatments, respectively) was compared. In addition, the 22-d growth performance of the lightest 14 pigs in each treatment was compared. Daily weight gain post-removal increased (P > 0.001) linearly as the proportion of the heaviest pigs/pen removed increased for the entire group (861, 942, 956, and 976 ± 19.5g/d for 0, 15, 30, and 45% removal treatments, respectively) as well as for the lightest 14 pigs (850, 927, 940, and 979 ± 20.4g/d, respectively). However, the total live weight of pigs produced decreased (P < 0.001) linearly as the proportion of the heaviest pigs/pen removed increased (3200, 3167, 3096, and 3024 ± 17.2kg for the 0, 15, 30, and 45% removal treatments, respectively). The within-pen coefficient of variation for the entire group at d 22 post-removal tended to decrease (P = 0.07) linearly as the proportion of the heaviest pigs/pen removed increased (9.39, 8.23, 8.36, and 7.69 ± 0.574 for the 0, 15, 30, and 45% removal treatments, respectively). These results suggest that removing 0 to 45% of the heaviest pigs in pens of slaughter weight pigs linearly increase growth rate of the remaining pigs, but reduce total live weight produced from the pen.

Key Words: Pigs, Removal, Growth

94 Using a stochastic model to evaluate swine production management with ractopamine (Paylean®) in a fixed production schedule environment. N. Li¹, A. P. Schinckel*², P. V. Preckel¹, and B. T. Richert², ¹Department of Agricultural Economics, Purdue University, ²Department of Animal Sciences, Purdue University.

The economically optimal return and management strategies for swine production with the application of Paylean were investigated for alternative fixed production schedule environments. A simulation approach using the stochastic model was employed. Pigs were assumed to be marketed under a payment scheme which has a 2:1 ratio between the value of dissected lean to fat tissue. The alternative fixed schedules were simulated as restricted marketing dates for the last batch of pigs. Fixed schedules investigated ranged from 137 d to 177 d, with a step size of 4 d and 157 d being the optimal marketing age of the last batch of pigs without any restrictions. Two types of Paylean management strategies were investigated: (1) fixing the dietary Paylean concentration as 6.5 ppm, which was optimal without restrictions; and (2) optimizing the Paylean concentration under each fixed schedule. The net returns of Paylean fed pigs over control pigs were higher for tight production schedules than for loose production schedules. The results indicated that the economic value of Paylean was higher when producers faced relatively tight schedules. When dietary Paylean concentrations were allowed to be optimized, pigs on tight schedules had relatively higher optimal Paylean concentrations than those with loose schedules. As expected, the net returns of the optimal Paylean concentrations were higher than or equal to those with a fixed Paylean concentration of 6.5 ppm. The optimal Paylean concentrations were 5.0 to 5.5 ppm with the three loosest schedules (169, 173, and 177 d) and ranged from 6.6 to 12.5 ppm for the four tightest schedules (149, 145, 141, and 137 d). The net returns per dollar spent on Paylean were higher for tight schedules than for loose schedules. In most cases, the supplementation of Paylean reduced the sort loss from underweight carcasses. Under all fixed environments examined, Paylean fed pigs produced a higher return than control pigs.

Key Words: Ractopamine, Pig, Management

95 Effect of short interval between final implant and harvest on metabolic function in bovine muscle. J. W. McCarthick*, R. H. Pritchard, J. A. Clapper, and M. D. Vukovich, *South Dakota State University*.

The purpose of this experiment was to determine the effects of harvest prior to implant payout on muscle glycogen levels in cattle. Steers (n=28) were blocked by body weight and assigned to one of two treatments. Steers in treatment CO were non-implanted controls. Steers in treatment IMP were implanted with Synovex Plus 70 d prior to harvest. Jugular blood and muscle biopsy samples (longissimus dorsi (LD) and semimembranosus (SM)) were collected 70 d post-implant, immediately prior to transit. Following transport (4 h; 408 km), additional blood and biopsy samples were taken. Muscle samples were obtained from the LD and SM of carcasses chilled 120 h. Implanting increased (P<0.05) ADG (17%), BW change (14%), and hot carcass weight (3%). Estradiol levels were lower in non-implanted cattle (9 pg/ml vs 19 pg/ml; P<0.01). Implanting had no effect (P>0.20) on pre-transit serum insulin/glucagon ratio (4.3 CO vs 5.4 IMP), or muscle glycogen level (98 μmol/g CO vs 89 μmol/g IMP). NEFA levels were greater in non-implanted steers pre-transit (0.15 mEQ/l vs 0.12 mEQ/l; P<0.01). Transit increased NEFA levels from 0.13mEQ/l pre-transit to 0.22mEQ/l post-transit (P<0.01), but did not affect glycogen levels (94 μmol/g pre-transit vs 93 μmol/g post-transit; P>0.15). Non-implanted steers tended to have a greater insulin/glucagon ratio (5.5 CO vs 4.0 IMP; P<0.15) post-transit. Implanting had no effect (P>0.20) on NEFA, or muscle glycogen levels (99 μmol/g CO vs 87 μmol/g IMP) post-transit, and had no biologically significant effect on muscle pH or objective color (L#42#, a, b) measurements. Implanting increased shear force (3.6 kg vs 4.5 kg; P<0.05). The LD had a greater amount of glycogen than the SM (100 μmol/g vs 83 μmol/g; P<0.05). Insulin/glucagon ratio and glycogen levels were highly variable (CV>35%). These data indicate that implants affect bovine metabolism, but other factors are necessary to induce a major metabolic change in muscle glycogen levels.

Key Words: Cattle, Implant, Glycogen

96 Utilization of lactic acid (LAC) or cetylpyridinium chloride (CPC) to reduce *E. coli* O157:H7 in inoculated cattle manure incubated at 5 or 37degC. S. L. Krumpelman*, J. K. Apple, E. B. Kegley, M. G. Johnson, and S. E. Watkins, *University of Arkansas*.

Escherichia coli (EC) O157:H7 is intermittently shed into the environment by cattle during periods of stress resulting in contamination of the hide at the time of harvest and potentially leading to EC O157:H7 in the food chain. A benchtop trial was conducted to determine the effects of application of LAC or CPC at two incubation temperatures on the growth of green fluorescent protein labeled EC O157:H7 inoculated (10⁷ cfu/g) into cattle manure. LAC and CPC were applied by spraying the surface of the manure at a rate of 3.6 and 1.4% of the wet manure, respectively, and treated samples were incubated at 5 or 37degC. Manure sub-samples were taken at 4, 24, and 48 h for bacterial enumeration of EC O157:H7, aerobic counts (APC), coliforms (COL), and generic EC. There were chemical treatment × time interactions for the enumeration of EC O157:H7 (P < 0.01), APC (P < 0.05), COL (P < 0.01), and generic EC (P < 0.001). CPC caused the greatest reduction (P < 0.05) at 4 h, followed by 24 and 48 h, as compared to the positive control in EC O157:H7 (4.77, 2.20, and 2.51 log cfu/g, respectively), APC (4.09, 2.62, and 2.83 log cfu/g, respectively), COL (5.06, 1.47, and 2.37 log cfu/g, respectively), and generic EC (4.93, 1.36, and 2.12 log cfu/g, respectively) counts. LAC reduced (P < 0.05) EC O157:H7, COL, and generic EC at 48 h (1.39, 1.33, and 1.06 log cfu/g, respectively), but not at 4 (0.60, 0.57, and 0.51 log cfu/g, respectively) or 24 h (0.78, 0.67, and 0.66 log cfu/g, respectively) as compared to the positive control; however, in APC, LAC reduced (P < 0.05) bacteria counts at 4, 24, and 48 h (0.87, 0.92, and 1.06 log cfu/g, respectively). At both 5 and 37degC, CPC caused the greatest reduction (3.35 and 3.00 log cfu/g, respectively; P < 0.001) in the growth of APC as compared to the positive control, followed by LAC (P < 0.01) at 37degC (1.29 log cfu/g) and then LAC at 5degC (0.61 log cfu/g; P < 0.05). Thus, CPC was the most effective treatment to quickly reduce bacteria in cattle manure.

Key Words: *E. coli* O157:H7, Manure Treatment, Pre-Harvest Control

97 A procedure for the isolation, culture, and cloning of bovine preadipocytes. A. C. Grant*, G. Ortiz-Colón, M. E. Doumit, and D. D. Buskirk, *Michigan State University*.

Adipose tissue accretion is partially influenced by the proliferation and differentiation of adipocyte precursor cells (preadipocytes). However, little information on bovine preadipocyte culture methods exist. Our objective was to develop a procedure for the isolation, culture, and cloning of bovine preadipocytes. Adipose tissue from subcutaneous (s.c.), intramuscular (i.m.), and perirenal (p.r.) fat depots of an Angus steer (558 kg, 13.5 mo. old) were excised, trimmed of extraneous tissues, and minced into 2 mm sections within 20 min of exsanguination. Samples were then digested for 1 h in Dulbeccos modified Eagle medium (DMEM) containing 2 mg per mL collagenase and 2% BSA. Digesta were then filtered through 1000 μ M, 500 μ M, and 53 μ M nylon mesh and centrifuged (10 min, 800 g). Pelleted cells were resuspended in growth media (DMEM containing 10% fetal bovine serum (FBS)), and seeded on 35 mm-diameter dishes. Four days after seeding, cells were trypsinized and reseeded on 10 cm-diameter dishes at clonal densities (400 cells per dish). After 10 to 14 d, colonies were isolated using a cloning ring technique. Clones produced intracellular lipid droplets within 2 to 14 d when grown to confluence and induced to differentiate in serum free media, (DMEM, 20 mM glucose, 10 mM acetic acid, 50 ng per mL insulin), with 0.25 μ M dexamethasone included for the first 48 h. When seeded at clonal densities and differentiated for at least 10 d, positive lipid staining with Oil Red O (ORO) was observed in \geq 88% of colonies from each depot with i.m. (88%) similar to s.c. (95%), but less than p.r. (100%), ($P < 0.05$). Compared with serum free media, differentiation in the presence of 1% FBS tended to reduce the percentage of ORO-stained colonies ($P = 0.08$). Our results show that preadipocytes from bovine adipose tissues can be successfully isolated, cloned and cultured. This system will provide a useful tool for elucidating the cellular mechanisms responsible for differences in fat accumulation among adipose depots.

Key Words: Intramuscular, Subcutaneous, Perirenal

98 Clonal efficiency and adipogenic capacity of preadipocytes isolated from bovine intramuscular, perirenal and subcutaneous adipose tissue. G. Ortiz-Colón*, A. C. Grant, M. E. Doumit, and D. D. Buskirk, *Michigan State University*.

The objective of this study was to evaluate differences in clonal efficiency (CE) and adipogenic capacity between subcutaneous (s.c.), intramuscular (i.m.) and perirenal (p.r.) presumptive preadipocytes (PA). Adipose tissue from each depot was isolated from an Angus steer (558 kg, 13.5 mo. old). PA obtained from 1 g equivalent of adipose tissue were seeded at 0.05 g/cm in growth media: Dulbeccos modified Eagle medium (DMEM) containing 10% fetal bovine serum (FBS). Four to seven days after seeding, PA were trypsinized, diluted to 5 cells/mL and seeded in 96 well uncoated plates (200 μ L/well). Six 96 well plates per depot were seeded: four plates with growth media (control), one plate with growth media + 1 ng/mL of fibroblast growth factor (FGF) (T1), and one plate with growth media + 10 ng/mL FGF (T2). The proportion of wells that had a single proliferative colony within each depot and treatment determined CE. PA were evaluated 8 to 13 d after seeding. An interaction existed between AT depot and treatment ($P < 0.001$). Within i.m. and s.c., control and T1 had greater CE than p.r. ($P < 0.001$). However, in T2 s.c. displayed greater CE than i.m. ($P < 0.001$), and i.m. had a greater CE than p.r. ($P < 0.01$). For i.m., T1 increased CE, and T2 decreased CE when compared with control ($P < 0.01$). In s.c., T1 increased CE when compared with control ($P < 0.001$), but did not differ from T2. For p.r. there was no treatment effect on CE. Clones from each depot (i.m., 48; s.c., 64; p.r., 11) were isolated and seeded at 10,000 cells per cm. At confluence, PA were exposed to differentiation media: DMEM supplemented with 1% FBS, 50 ng insulin/mL, 20 mM glucose, 0.25 μ M dexamethasone, and 10 mM acetate. PA exhibiting positive staining of lipid with Oil-red O were considered adipogenic. There was no difference in the proportion of adipogenic clones between s.c. (47.7%) and p.r. (45.5%), however, both depots exhibited a greater proportion of adipogenic clones than i.m. (12.5%) ($P < 0.01$). CE, responsiveness to FGF and the proportion of adipogenic cells depended on the adipose tissue depot from which the PA were isolated.

Depot	Control	CE, %		SEM
		T1	T2	
i.m.	50.0 ^{ax}	63.5 ^{ay}	34.7 ^{az}	4.6
s.c.	49.7 ^{ax}	69.8 ^{ay}	59.0 ^{bx}	4.9
p.r.	13.1 ^{bx}	12.5 ^{bx}	15.8 ^{cx}	4.6

^{abc}Means with different superscripts within the same column differ ($P < 0.05$).

^{xyz}Means with different superscripts within the same row differ ($P < 0.05$).

Key Words: Preadipocytes, Clonal Efficiency

99 Using a stochastic model to optimize swine production management strategies with ractopamine (Paylean®). N. Li¹, A. P. Schinckel*², P. V. Preckel¹, and B. T. Richert², ¹Department of Agricultural Economics, Purdue University, ²Department of Animal Sciences, Purdue University.

The management of pig production with the feeding of Paylean was investigated for a group of gilts using a stochastic growth model, which allowed each individual pig to have a unique body weight and carcass composition growth curve. A bio-economic model was developed based on the stochastic growth model, which incorporated the economic optimization principles of livestock replacement, pig growth under optimal dietary lysine intake, and pig growth response to Paylean. The optimal production and marketing decisions for feeding Paylean, including both dietary lysine and Paylean management were derived. The optimal management was derived for four payment schemes, simulating producers with various marketing channels and market structures. The four payment schemes were: (1) carcass payment with discounts on underweight and overweight carcasses; (2) carcass merit payment system adopted from Hormel's Carcass Lean Value Program; (3) lean to fat price ratio of 2:1, with discounts on underweight and overweight carcasses; and (4) lean to fat price ratio of 4:1, with discounts on underweight and overweight carcasses. It was assumed that pigs were marketed by semi-truck with a capacity of 170 head. The optimal Paylean concentrations were 5.0, 5.5, 6.5, and 9.5 ppm for marketing systems 1 to 4, respectively. The optimal average days of Paylean feeding were 24.3, 27.2, 28.2, and 29.0 d for marketing systems 1 to 4, respectively. The net returns from using Paylean were estimated to be from 5,624 to 16,368 per year for a 1000-head grow-finish facility. These annual net returns from using Paylean corresponded to 1.77 to 4.93 higher returns per pig than control pigs. The net returns from using Paylean increased from payment scheme 1 to 4, as the lean to fat price ratios increased. Sort loss from pigs with the optimal marketing and Paylean-treatment was higher than that for control pigs under each payment scheme. With Paylean adoption and its higher returns, it was economically optimal to sacrifice some sort loss in order to market the pigs at younger age and have a faster barn turn-over.

Key Words: Ractopamine, Pig, Management

100 Growth curve analysis of early versus traditional weaned beef steers. D. L. McNamara*¹, E. L. Walker², M. S. Kerley¹, D. H. Keisler¹, V. L. Pierce¹, T. B. Schmidt¹, C. A. Stahl¹, M. L. Linville¹, and E. P. Berg¹, ¹University of Missouri, ²Southwest Missouri State.

The objective of this study was to generate growth curve data from early weaned (EW) and traditional weaned (TW) beef cattle using ultrasound measures (Auskey System, Animal Ultrasound Services, Ithaca, NY) and body weights. Growth curves were derived according to time on a high concentrate diet (time on feed; TOF) and in accordance to days of age (DOA). Angus X Gelbvieh steers (n = 140) were randomly assigned to a 2 x 2 factorial split-plot design. Treatments consisted of early weaned calves (weaning age = 90d; n = 70) and normal weaned calves (weaning age = 210d; n = 70) fed a traditional feedlot ration. Body weights and 12th rib fat thickness (FT), ribeye area (REA), and USDA marbling scores were ultrasonically obtained at 28d intervals from point of weaning to harvest. At weaning, TW calves (210 DOA) had a significantly higher amount of FT ($P < 0.01$) than EW calves (90 DOA). The TW steers maintained higher BF measures ($P < 0.01$) throughout the TOF, yet the EW calves had significantly higher BF ($P < 0.01$) at harvest. At weaning TW calves had a larger REA and continued this pattern throughout TOF ($P < 0.01$), however, EW calves finished with a larger REA ($P < 0.01$). Although marbling scores were higher for EW calves

relative to TOF ($P < 0.01$), no differences were observed at harvest ($P > 0.1$). As expected, TW calves were heavier at weaning ($P < 0.01$) and throughout the TOF period, however, harvest weights had no difference ($P > 0.1$). Average daily gains were higher for TW calves at the time of weaning ($P < 0.01$) and for 4 of the 5 feeding periods thereafter ($P < 0.01$). These differences in ADG were also observed relative to DOA until the final month where no differences were observed. ($P = 0.82$). The longer feeding duration of EW steers resulted in larger REA and higher BF, however, no other differences in carcass parameters or body weight were seen.

Key Words: Beef, Growth Curve, Early Weaning

101 Color of enhanced beef steaks during retail display when packaged under various modified atmosphere packaging systems. C. R. Calkins* and M. L. Buford, *University of Nebraska*.

This study was conducted to determine the color of enhanced beef during retail display when packaged under various modified atmosphere packaging (MAP) systems. Steaks from beef strip loins and top sirloin butts were commercially enhanced with a solution of salt and phosphate (the top sirloin steaks were lightly misted with a solution of rosemary extract), and allocated to 3 packaging systems, two lengths of dark storage time (8 or 15 d) and two retail display periods (1 or 3 d). The packaging systems included a high-oxygen tray system [hi-ox], a low-oxygen system in a peelable tray to facilitate oxygenated retail display [low-ox], and vacuum packages. Color was scored using a 5-point rating scale, where 1=extremely bright red and 5=dark red or brown (for the hi-ox and low-ox systems) while 1=bright purplish red and 5=brown for the vacuum packages. Discoloration was estimated to the nearest decile. Vacuum packaged steaks had the most stable color scores ($P < .05$) and were the least discolored ($P < .05$) during retail display, regardless of dark storage time. They also had the lowest L^* values ($P < .05$), along with low-ox steaks following 15 d of dark storage. For both steak types, the low-ox tray (regardless of length of dark storage time) and the hi-ox package with 15 d of dark storage resulted in the greatest ($P < .05$) degree of retail discoloration. Strip steaks in low-ox trays had the darkest/most brown color ratings after retail display. The lowest a^* values (least red) were noted after 3 d of retail display when either steak type was packaged in a hi-ox or low-ox tray, stored in the dark for 15 d and held in retail for 3 d. The hi-ox system showed minimal discoloration after 8 d of dark storage; storage for 15 d resulted in more ($P < .05$) discoloration and less desirable ($P < .05$) colors. The best results were obtained when dark storage was limited to 8 d and retail display was terminated after 1 d. Under these favorable conditions, the high-oxygen packaging and the vacuum packaging systems were most effective.

Key Words: Beef, Color, Packaging

102 Sensory properties of enhanced beef steaks following retail display when packaged under various modified atmosphere packaging systems. C. R. Calkins* and M. L. Buford, *University of Nebraska*.

This study was conducted to determine the sensory properties of enhanced beef during retail display when packaged under various modified atmosphere packaging (MAP) systems. Steaks from beef strip loins and top sirloin butts were commercially enhanced with a solution of salt and phosphate (the top sirloin steaks were lightly misted with a solution of rosemary extract), and allocated to 3 packaging systems, two lengths of dark storage time (8 or 15 d) and two retail display periods (1 or 3 d). The packaging systems included a high-oxygen tray system [hi-ox], a low-oxygen system in a peelable tray to facilitate oxygenated retail display [low-ox], and vacuum packages. Following retail display, steaks were frozen and stored for about 100 d prior to sensory evaluation by a trained, 10-member panel. Steaks were thawed overnight and broiled to 70 C. Panelists rated juiciness, tenderness, flavor intensity, and off-flavor intensity on 8-point rating scales, where 1=extremely dry, extremely tough, extremely intense flavor, extremely intense off-flavor and 8=extremely dry, extremely tough, extremely intense flavor, extremely intense off-flavor. Increasing the lengths of dark storage and retail display times caused an increase ($P < .05$) in off-flavor intensity and more frequent off-flavor notes for both strip and top sirloin steaks. The hi-ox system had the greatest amount of off-flavors and off-flavor

intensity ratings, especially after 8 d of dark storage for the top sirloin steaks. Tenderness was rated lowest for the hi-ox steaks ($P < .05$). There were significant off-flavor issues for most of the enhanced beef steaks in this study. The best results were obtained when dark storage was limited to 8 d and retail display was terminated after 1 d. Under these favorable conditions, the hi-ox and vacuum packaging systems were most effective.

Key Words: Beef, Packaging, Flavor

103 Use of nucleic acid aptamers to detect ADP-ribosylation of muscle cytoskeletal proteins. B. D. Brooks*¹, D. H. Burke², R. M. Robson¹, and T. W. Huiatt¹, ¹*Iowa State University*, ²*Indiana University*.

The objective of this project was to develop a method to detect ADP-ribose modification of muscle and other tissue proteins, in order to understand the role of this important protein modification in muscle development. ADP-ribosylation is the transfer of ADP-ribose from NAD to an amino acid side chain of a protein. ADP-ribose is removed by a specific hydrolase, providing a reversible pathway that modifies protein function and can act in cellular signaling. Three arginine-specific ADP-ribosyltransferases (ARTs) and a cytoplasmic ribosylarginine hydrolase are expressed in skeletal muscle. We have previously shown that inhibition of arginine-specific ADP-ribosylation in embryonic skeletal muscle blocks myoblast differentiation, indicating an important role for this reaction in muscle development. We have shown that the muscle, cytoskeletal intermediate filament protein desmin can be ADP-ribosylated *in vitro* by purified muscle ART, and that ADP-ribosylation blocks desmin filament assembly. Characterization of the function of ADP-ribosylation in muscle requires a method to identify ADP-ribosylated proteins. We have developed such a method using nucleic acid aptamers that bind adenosine. Aptamers are small RNA or DNA molecules selected for specific binding to a ligand by SELEX (Systematic Evolution of Ligands by EXponential enrichment). Two RNA aptamers selected for binding to Coenzyme A, 70CoA68 and 70PSA5, bind AMP *in vitro*. Autoradiography of dot blots spotted with ADP-ribosylated proteins, including desmin, vimentin and glycogen phosphorylase, and overlaid with radiolabeled aptamers demonstrated binding of these aptamers to the ADP-ribosylated proteins, but not to control proteins with no bound ADP-ribose. Quantitation of blots by scintillation counting demonstrated that the binding was saturable. We then used aptamer 70 CoA68 to identify ADP-ribosylated desmin in homogenates from muscle cell cultures. Thus, these aptamers provide a novel tool for examining the function of ADP-ribosylation and for understanding the role of this protein modification in muscle development. (Supported by USDA-NRRCGP 20033520612823)

Key Words: ADP-Ribosylation, Intermediate Filaments, Muscle

104 The effect of pre-rigor water injection and post-rigor sodium citrate treatment on beef tenderness. B. M. Sitz, P. Matayompong*, C. D. Perversi, and C. R. Calkins, *University of Nebraska*.

Previous research in our laboratory indicated that beef muscles injected pre-rigor with water were less tender than control samples. We hypothesized that pre-rigor water injection diluted intramuscular calcium to the point that rigor contraction and calpain activities were minimized and that sodium citrate would enhance tenderness independent of this effect. To test this hypothesis, thoracic limbs from 20 beef steers were removed pre-rigor and treated in one of four ways or they were removed after 24 hr (post-rigor control). There were five treatments: (1) left on the carcass to enter rigor (post-rigor control), (2) removed pre-rigor and otherwise untreated (pre-rigor control), (3) removed pre-rigor and left untreated for 24 hr, when they were pumped to 15% with a solution of 4% sodium citrate (0/citrate), (4) removed pre-rigor, injected to 10% weight with tap water, then injected post-rigor with 5% more tap water (water/water), and (5) removed pre-rigor and injected to 10% with tepid, tap water, then injected post-rigor to 5% with a solution of 12% sodium citrate (water/citrate). Shear force values were determined on steaks from the infraspinatus, supraspinatus, and triceps brachii muscles cooked to 70 C after 3 and 7 days post-mortem. For each muscle at each aging time (except infraspinatus 0/citrate versus water/water at 3 d post mortem), citrate-treated muscles (0/citrate and water/citrate,

which were never different in tenderness from each other) were significantly more tender than the water/water and the post-rigor control treatments (which were never different in tenderness from each other), suggesting citrate can overcome whatever limits to tenderization are caused by pre-rigor injection of water. Sarcomere length did not differ among treatments within muscles or aging times ($P > .05$). Pre-rigor removal of the thoracic limb actually increased tenderness in the infraspinatus and the supraspinatus when compared to the post-rigor control ($P < .05$), which likely occurred as a result of altered muscle position. It appears sodium citrate can tenderize meat independent of water injection.

Key Words: Beef, Tenderness

105 Consumer preference and value for country-of-origin labeling on beef. B. M. Sitz¹, C. R. Calkins*¹, W. J. Umberger², and D. M. Feuz¹, ¹University of Nebraska, ²Colorado State University.

This research was conducted to determine the extent to which consumers might prefer country-of-origin labeling in isolation of other beef attributes and to determine the relative importance of country-of-origin labeling to other product selection criteria. In the summer of 2002, consumers in Denver (n=132) and Chicago (n=141) completed a written survey and then were shown two strip steaks (cut consecutively from a loin). One contained a label (8.5 x 6 cm) with the U.S. flag in color, covered by the phrase U.S.A. Guaranteed and bordered with the phrase Born and Raised In The United States of America. There were no other differences between the steaks. A moderator explained that both steaks were inspected and passed by the U.S.D.A. They were told the unlabeled steak may or may not have been born and raised in the U.S. A reference price of \$7.00 for the unlabeled steak was given. Consumers were asked to write a hypothetical monetary value they would be willing to pay for each steak and to explain why. On the survey, most consumers (74.7%) preferred to purchase beef with the country-of-origin label, but 22.3% did not care. The most common reason given was safety and health of meat (45%). They ranked hamburger, then steak, and roasts as products most preferred for country-of-origin labeling. Of 17 listed items, freshness and inspected for food safety were the most desirable characteristics when purchasing beef; country-of-origin labeling was rated ninth. Based on prices for the labeled steaks, 69.2% of consumers were willing to pay more for country-of-origin labeling and they were willing to pay, on average, 18.7% more (\$5.14 vs \$4.33, $P < .05$). When presented in isolation of other beef attributes, most consumers were willing to pay a premium for country-of-origin labeling. Many appear to use this information as an indication of food safety. By itself, country-of-origin labeling was judged to be of intermediate importance, following issues of freshness and safety.

Key Words: Beef, Labeling, Preference

106 Early prediction of ultimate purge and color in boneless pork loins intended for domestic or export use. T. W. Holthaus*¹, R. C. Johnson², and C. R. Calkins¹, ¹University of Nebraska, ²Farmland Foods, Inc.

To evaluate the effectiveness of technologies applied within 24 hr post-mortem in predicting ultimate purge and color in boneless pork loins intended for domestic or export use, 600 pork carcasses in a commercial pork plant were sampled (300/winter and summer season). Half of the carcasses were designated for domestic use and the other half to export. Less than 1 hr post-mortem all carcasses were weighed and evaluated with the Fat-O-Meater for fat and muscle depth at the 11/12 rib interface. Each loin was evaluated 24 hr post-mortem at the 6/7 rib interface and the last rib with a Hennessey Grading Probe (HGP; for lean color and color variation), electrical impedance spectroscopy (EIS), and a pH probe. Domestic loins were held for 21 d and export loins were held 42 d. Following storage, purge was defined as overall liquid in the vacuum bag and color (L*) was measured using a ColorTec colorimeter. Regression models were constructed from the following variables: season, fat depth, muscle depth, hot carcass weight, HGP color, HGP color variation, pH, EIS resistance at 55 and 112 KHz. The most appropriate models excluded any measures from the EIS system. Measures taken at the last rib yielded a coefficient of determination (C.D.) of 21.0 and 9.2 for domestic and export purge, respectively. Those same measures gave a C.D. of 29.8 and 28.1 for domestic and export loin color, respectively.

Measures taken at the 6/7 rib interface were about the same. Prediction of ultimate purge by measures taken within 24 hr post-mortem was unsuccessful while prediction of color was slightly better. Development of models to screen out undesirable loins in advance of shipping demonstrated an unacceptably high rate of incorrect rejection, regardless of storage duration or trait (purge or color). As applied in this study, these technologies are not sufficient at the commercial level to allow prediction of ultimate purge and color in boneless, vacuum packaged pork loins.

Key Words: Pork, Color, Water Holding Capacity

107 Evaluation of single and re-implant strategies on performance, carcass traits and longissimus muscle tenderness of finishing beef steer calves. J.D. Arseneau*¹, M.C. Claeys¹, J.W. Leininger², J.P. Hutcheson², and R.P. Lemenager¹, ¹Purdue University, ²Intervet, Inc.

The objective of this study was to compare effects of single versus re-implant programs on growth performance, carcass traits, and tenderness of finishing beef steer calves. Crossbred steer calves (n = 128; average BW = 268 kg) were blocked by weight and assigned to four implant treatments in a completely randomized block design. Implant treatments were: 1) nonimplanted control (C); 2) Revalor-S on d 1 (S); 3) Revalor-IS on d 1 (IS); and 4) Revalor-IS on d 1 and d 84 (IS/IS). Steers were harvested at an estimated 1.1 to 1.2 cm 12th rib fat depth. At 24 h post-harvest, a strip loin steak was removed from each carcass and wet-aged 14 d for determination of shear force measurement. Over the entire feeding period, IS/IS steers had 16.3% greater ADG and 8.4% improved feed efficiency compared to C cattle ($P < 0.10$). Daily gains were improved 6.5% ($P < 0.10$) from reimplanting (1.64 versus 1.54 and 1.54 kg/d for IS/IS, S, and IS, respectively). Daily gains of S and IS steers were 9.2% higher than C ($P < 0.10$), while IS steers were 5.8% more ($P < 0.10$) efficient than C. On a carcass-adjusted basis, ADG and feed efficiency did not differ ($P > 0.10$) between implant treatments, but implanted steers gained faster and were more efficient than C steers ($P < 0.05$). Non-implanted steers required 14 more d on feed ($P < 0.10$) than IS steers to reach a similar fat endpoint. Hot carcass weights of S and IS/IS steers were heavier ($P < 0.10$) than those of C and IS, while dressing percentage was higher ($P < 0.10$) for S than C and IS. Longissimus muscle areas (LMA) of S carcasses were larger ($P < 0.10$) than those of C and IS, and LMA were greater ($P < 0.10$) for IS/IS carcasses than C carcasses. Percentage KPH, calculated yield grade, and longissimus steak shear force were not different among treatments ($P > 0.10$). Marbling scores and percentage of carcasses grading USDA Prime were greater for C carcasses than carcasses from implanted cattle ($P < 0.10$). In this study, a Revalor-IS/Revalor-IS implant program enhanced performance and feed efficiency, reduced marbling scores, but did not effect tenderness of steaks.

Key Words: Beef, Implant, Revalor

108 The effects of swine finishing environment on fresh pork quality. B. S. Patton*¹, M. S. Honeyman¹, R. C. Johnson², and S. M. Lonergan¹, ¹Iowa State University, ²Farmland Foods Inc.

The objective of this study was to examine the effects of finishing environment on carcass and muscle quality traits. Four hundred crossbred (Musclor x Duroc x Large White x Landrace) pigs were finished in north-western Iowa during the months of July - October 2003 in two different finishing environments. Finishing environments included standard ventilated confinement and hoop structures. Hoops are deep bedded, open-ended structures with a fabric roof. Nutrition, age and management were standardized across the two environments. All data were collected at a commercial processing facility. Pigs were slaughtered at approximately 123 kg live weight. Carcass measurements of backfat thickness, loin eye depth and hot carcass weight (HCW) were evaluated. One hundred sixty carcasses were randomly chosen for meat quality assessment. Evaluation of right side loins included National Pork Board color, firmness, marbling, and wetness scores, 24 hour pH (pHu), CIE L* a* b*, hue angle and saturation index. Loins were measured on the blade end of the longissimus dorsi at the 4th thoracic vertebrae. Hoop-finished pigs had higher HCW and firmness values ($P < 0.05$) compared to the confinement-finished hogs. Finishing environment did not affect backfat thickness or loin eye depth ($P > 0.05$). Loins from pigs finished in the two environments did not differ ($P > 0.05$) in quality measurements of

NPB color, marbling, and wetness scores, or pHu, CIE L* a* b*, hue angle or saturation index scores. These data indicate that there were no substantial differences in fresh pork quality in loins from pigs finished in different systems. Hoop-finished pigs exhibited a higher HCW and firmness scores with similar backfat thickness of confinement pigs. Though there were no observed differences in pHu, pH decline will be of interest in future trials. The effect of finishing system on product firmness is an interesting observation that merits continued investigation.

Key Words: Finishing Environment, Hoop Structure, Pork Quality

109 The effect of duration of carcass scalding on pork quality. G. Ch. Mendez*¹, E. Huff-Lonergan¹, J. O. Matthews², C. M. Schultz-Kaster², and S. M. Lonergan¹, ¹Iowa State University, ²Premium Standard Farms.

The objective of this study was to determine the impact of duration of carcass scalding on pork loin color, water holding capacity and texture. Commercial pigs (n=655) were slaughtered at a commercial processing facility on two days within one week. Three hundred thirty six pigs were harvested and assigned to scald duration treatment groups of 7.6 (n=161) or 5.6 (n=175) min. The procedure was replicated on a separate day (7.6 min scald, n=150; 5.6 min scald, n=169) with the slaughter order of the treatments reversed. As a consequence of a shorter scalding duration, carcasses in the 5.6 min scald treatment entered the cooler 5 min earlier than the 7.6 min scald treatment. Loin temperature and pH were recorded as carcasses entered the cooler, at 2 h and 6 h postmortem. Loins representing each treatment group were selected for meat quality evaluation. Loin quality traits measured at 24 h (n=260) included pH, temperature, color, and drip loss. Purge loss, color, pH, and star probe values were measured on chops aged 5 d postmortem (n=160). The longer duration of scalding resulted in higher loin pH as carcasses entered the cooler (P < 0.01), but lower pH at 2 h postmortem (P < 0.01). Loin pH did not differ between treatments at any other time measured. Treatment did not influence loin temperature at cooler entry or 2 h postmortem. The longer duration of scalding produced pork loins with greater drip loss (P < 0.01), and higher L* values at 24 h postmortem (P < 0.05). At 5 d postmortem, loins from carcasses in the longer scald treatment had higher L* values (P < 0.01), b* values (P < 0.01), and greater discoloration as determined by hue angle (P < 0.05). Treatment differences for loin a* values, purge, cook-loss, and star probe values were not observed. These data suggest that shortening the duration of scalding, coupled with earlier entry in the cooler, has no detrimental effects on pork quality and may improve pork color and water holding capacity.

Key Words: Pork Quality, Pork Processing

110 Effect of dietary lipoic acid on growth performance and carcass characteristics of finishing steers. T. B. Schmidt, M. M. Brandt*, K. C. Olson, D. L. McNamara, C. A. Stahl, D. J. Newman, G. K. Rentfrow, D. J. Kemp, C. C. Carr, and E. P. Berg, University of Missouri.

Eight-four Angus cross steers (BW=379 24kg) were used to evaluate the benefits of supplementation of lipoic acid on growth performance and carcass characteristics of finishing steers. Treatments were control (CON: no lipoic acid), lipoic acid supplemented at 8 mg/kg BW (LA8), and lipoic acid supplemented at 16 mg/kg of BW (LA16). Steers were fed a 90% concentrate diet designed to promote a 1.6 kg ADG for 125 d. Lipoic acid was incorporated into an extruded pellet containing 90% corn flour and 10% lipoic acid. Control cattle received a 100% corn flour pellet. Pellets were top dressed immediately following daily delivery of feed and mixed into the feed. No treatment differences were observed for ADG, DMI, or G:F. Similarly, no treatment differences were detected for HCW, marbling score, 12th rib fat-thickness, REA, KPH, and final yield grade. Lipoic acid treatments had more (P < 0.05) yield grade 4 and 5 carcasses than controls (0, 4, and 5% for CON, LA8, and LA16, respectively). Warner-Bratzler shear force (WBSF) were lower (3.96 kg; P < 0.05) for LA16 steers compared to CON (4.24 kg) at 7 d of aging, while WBSF were higher (4.57 kg; P < 0.05) for LA8 compared to control steers. At 14 and 21 d of aging, no differences in WBSF between the three treatments were observed. Lipoic acid supplemented at 8 mg/kg of

BW or 16 mg/kg BW appeared to have no effect on growth performance of finishing steers, while adversely affecting yield grade.

Key Words: Lipoic Acid, Quality, Growth

111 Effect of supplemental dietary lipoic acid on the color and shelf-life of beef longissimus muscle. T. B. Schmidt*, K. C. Olson, C. A. Stahl, M. M. Brandt, D. L. McNamara, M. L. Linville, D. J. Kemp, C. C. Carr, and E. P. Berg, University of Missouri.

To evaluate the effect of lipoic acid on color stability and shelf-life of fresh steaks, 36 whole ribs (6th-12th rib, IMPS/NAMP 107) were randomly removed from beef carcasses representing steers (n=82) supplemented with lipoic acid for 125 d prior to harvest (12 ribs per treatment group). Lipoic acid (LA) was supplemented at three levels, control (CON: zero lipoic acid), 8 mg/kg of BW (LA8), and 16 mg/kg of BW (LA16). Ribs were removed approximately 24 h postmortem, vacuum packaged, boxed, and shipped to the University of Missouri Meats Laboratory for fabrication into 2.54 cm-thick boneless steaks. Two steaks from each rib were vacuum packaged aged for 7 and 14d. After aging, steaks were placed in Styrofoam trays, over wrapped with oxygen permeable polyvinyl chloride packaging film, and placed in a commercial retail display case (2 C; continuous cool fluorescent lighting 1350 to 1400 lux). Color was measured objectively with a Hunter Mini-scan (CIE L*, a*, and b* color analysis), and subjectively by a 10 member panel (color 5 point scale: 1=very bright cherry red and 5=tan to brown). After 7 d aging, L* values were similar for LA16 and CON, however, by 6 d, L* was greater (P < 0.05) for LA16 compared to LA8 (35.03) and CON (36.08). While a* values for LA16 were numerically higher than CON, there was no significant difference between treatment (P > 0.05). Values for b* were greater (P < 0.05) for LA16 on d 1, 2, and 3 (19.99, 19.27, and 19.72 respectively) compared to CON (18.28, 17.78, and 18.75, respectively). After 14 d aging, L* values were greater (P < 0.05) for LA16 compared to CON and LA8 for days 1 thru 3; days 4 thru 6 were not different. No differences were seen in a* or b* values for the three treatments after 14 d aging. No treatment effect was observed for subjective color scores on steaks aged 7 d. LA16 steaks aged 14 d had a significantly lower (P < 0.001) color score for 5 and 6 d compared to LA8 and CON. No antioxidant affect was observed for LA fed at 8mg/kg of BW, and limited affects were observed for LA fed at 16mg/kg of BW.

Key Words: Antioxidant, Shelf Life, Color

112 Effect of aging method on tenderness and consumer sensory evaluation of beef strip loin and rib steaks. J. D. Arseneau*, T. L. Selby, M. C. Claeys, J. C. Forrest, R. H. Linton, and R. P. Lemenager, Purdue University.

The objective of this study was to evaluate the effects of different aging methods on tenderness and consumer sensory evaluation of beef strip loin and rib steaks. The right and left sides from USDA Choice carcasses (n=29) were randomly assigned to different aging methods. One side of each carcass was dry-aged for 14 d (DRY). The remaining side was dry-aged for 7 d, and then the primal rib and short loin were removed, vacuum-packaged and wet-aged for an additional 7 d (DW). After the 14 d age, rib and strip loin steaks were cut (2.54 cm thick), trimmed and frozen for consumer sensory evaluation and Warner-Bratzler shear force. Microbial evaluation was conducted pre-chilling, at 24 h postmortem and after a 14 d total age. An additional treatment (RET) consisted of rib and strip steaks purchased from a retail store to serve as a comparison to product available to consumers at the retail level. Consumer sensory panels rated steaks for tenderness, juiciness, beef flavor intensity and overall acceptability (8=extremely tender, juicy, intense and acceptable; 1=extremely tough, dry, bland and unacceptable). Warner-Bratzler shear values did not differ between treatments for rib or strip loin steaks. Consumer panelists rated DRY rib steaks more tender (P < 0.01) than rib steaks from RET, while juiciness scores differed (P < 0.03) between the three aging methods (5.25, 5.08 and 4.82 for DRY, DW and RET, respectively). Rib steaks from DRY and DW received higher (P < 0.001) sensory panel ratings for beef flavor intensity (5.46 and 5.43) and overall acceptability (5.63 and 5.56) compared to RET (5.25 and 5.26). Sensory panel attributes did not differ between treatments for strip loin steaks. Cooking loss was higher (P < 0.01) for RET rib and strip steaks compared to DRY and DW steaks. There were no differences between DRY and DW for levels of aerobic plate counts,

total coliforms, *E. coli*, or presence/absence of *Salmonella spp.* Results from this study demonstrate that a 7 d dry/7 d wet-aging combination results in similar consumer sensory panel ratings for tenderness, beef flavor intensity and overall acceptability to a 14 d dry-age.

Key Words: Beef, Carcass, Aging

113 Effect of delayed implanting on feedlot gain and carcass traits in steer calves. R. N. Funston* and D. C. Adams, University of Nebraska.

One hundred crossbred (5/8 Red Angus, 3/8 Continental) steer calves (206 kg; not previously implanted) were used to evaluate the effect of delaying initial implanting on feedlot and carcass characteristics. Steers were acclimated together on a receiving diet for 14 d and then allotted to implant treatment by BW. One half of the steers were implanted with Synovex S[®] (14.5 mg estradiol and 200 mg progesterone) after the acclimation period (d 0), the remainder was implanted 30 d later. All calves were re-implanted at d 112 after the beginning of the study with Synovex Choice[®] (10.1 mg estradiol and 100 mg trenbolone acetate) and harvested 100 d later. Interim BW was taken at the time the second group received their first implant (d 30), at re-implant (d 112), and near harvest (d 203). Final weights were calculated using hot carcass weight adjusted to a common dressing percentage (63). Steers implanted at the beginning of the study were heavier ($P = 0.01$) at 30 d than delayed-implanted steers (280 and 268 kg for non-delayed and delayed, respectively). Body weight was not different ($P > 0.10$; 418 kg) at the time of re-implant. Neither final weight (576 kg) nor ADG (1.70 kg/d) were affected ($P > 0.10$) by implant regimen. Hot carcass weight (363 kg), back fat (1.22 cm), ribeye area (82.58 cm²), and yield grade (3.22) were also unaffected ($P > 0.10$) by implant regimen. However, delayed-implant steers had a higher ($P < 0.01$) percentage grading Choice (92 vs 68 %). Delaying implanting resulted in a 24 % increase in cattle grading Choice at harvest without affecting overall ADG or other carcass characteristics measured.

Key Words: Implants, Marbling, Feedlot

114 Conjugated linoleic acid content of ribeye steaks from beef finished on pasture. C. L. Lorenzen*, J. W. Golden, F. A. Martz, I. U. Gruen, J. R. Gerrish, and K. C. Moore, University of Missouri.

Conjugated Linoleic Acid (CLA) is a naturally occurring fatty acid found in animal fats and has been shown to have many healthful benefits to humans. CLA content is higher in ruminant animals and may be linked to their diet. The objective of this project was to determine CLA content of *Longissimus lumborum* from beef finished on pasture or grain supplement regimes. Crossbred cattle were allotted randomly to one of four feeding regimes; pasture ($n = 11$), pasture with grain supplement ($n = 11$), pasture with grain supplement containing soyoil ($n = 12$), and a feedlot diet ($n = 12$). Grain supplementation intake was limited to 1.25% of the body weight. Cattle were processed after a minimum of 100 d on feed and a target fat thickness of .76 cm. USDA yield and quality grade data was collected and the ribeye roll was processed into 2.54 cm steaks for chemical analysis and Warner-Bratzler shear force. Fatty acid profile was determined by gas chromatography on raw and cooked ribeye steaks. Cattle fed the feedlot diet had higher ($P < .05$) values for all USDA yield and quality grade traits compared to the other three feeding regimes. USDA quality grade, Select-, did not differ ($P > .05$) for cattle finished on pasture or finished on pasture with grain supplements. Warner-Bratzler shear force values did not differ ($P > .05$) between feeding regimes. Fat percentage was the highest ($P < .05$) in meat from cattle finished on the feedlot diet. Meat from cattle finished on pasture with grain supplement containing soyoil had the highest ($P < .05$) total CLA content in both raw and cooked *Longissimus lumborum*. Ribeye steaks from cattle finished on a feedlot diet had the lowest ($P < .05$) total CLA content for cooked steaks when expressed as mg/g of fat.

Key Words: Meat, Conjugated Linoleic Acid, Pasture

115 Influence of hide thickness on the ability to predict percent intramuscular fat with real-time ultrasound in beef cattle. R. G. Tait, Jr.*, C. Lukavsky, G. H. Rouse, D. E. Wilson, and A. T. Hassen, Iowa State University.

Four (4) longitudinal real-time ultrasound images were collected on 740 head of cattle to predict percent intramuscular fat. These four measures were subsequently averaged to provide ultrasound predicted percent intramuscular fat (UPFAT) measures for each animal. Ultrasound images were collected with both Aloka 500 (Aloka USA, Wallingford, CT) ($n = 245$) and Classic Scanner 200 (Classic Medical Supply, Tequesta, FL) ($n = 495$). Thickness of the hide on each animal was determined by measuring the first image collected on each animal. Percent intramuscular fat (PFAT) was determined by chemical extraction on a *longissimus dorsi* sample from each animal. Summary statistics for percent intramuscular fat were 1) mean 4.58% and 4.57%, 2) standard dev. 1.65% and 1.30%, 3) minimum 1.15% and 1.50%, and 4) maximum was 11.38% and 9.90% for PFAT and UPFAT, respectively. A miss was calculated for each animal by subtracting PFAT from UPFAT. Hide thickness was not a significant predictor of miss ($P = 0.13$) or absolute value of miss ($P = 0.57$). When the data were subdivided by ultrasound technology hide thickness was a significant predictor of miss ($P < 0.01$ for both technologies). However, a different trend was established for each technology. The Aloka 500 underpredicts PFAT as hide thickness increases, and the Classic Scanner 200 overpredicts PFAT as hide thickness increases. When these data were divided into thin (≤ 0.38 cm) hided cattle ($n = 364$) and thick (> 0.38 cm) hided cattle ($n = 376$), the actual percent intramuscular fat mean was 4.70% and 4.46% and standard deviation was 1.73% and 1.55% for thin and thick hided cattle, respectively. Ultrasound predicted percent intramuscular fat means were 4.76% and 4.39% and standard deviations were 1.39% and 1.17% for thin and thick hided cattle, respectively. Overall it appears that hide thickness does not impact the ability of ultrasound technology to predict percent intramuscular fat in beef cattle. It is possible that hide thickness will have different impact on differing ultrasound technologies abilities to predict percent intramuscular fat in beef cattle.

Key Words: Ultrasound, Beef Quality, Prediction

116 Influence of digital cineloop on Classic Scanner 200 image collection to predict percent intramuscular fat in beef cattle. R. G. Tait, Jr.*, G. H. Rouse, D. E. Wilson, and A. T. Hassen, Iowa State University.

Real-time ultrasound images were collected on 34 head of Angus steers using the Classic Scanner 200 (Classic Medical Supply, Tequesta, FL). A series of eight (8) images on each animal were collected by saving the image when the image was frozen (FROZEN), as well as the immediately preceding image stored within digital cineloop (ROLLBACK), representing 4 independent measures of intramuscular fat on each animal for both FROZEN and ROLLBACK image types. Images were later interpreted in a research interpretation lab with software developed by Iowa State University. The region of interest, or box, placement was in the same location on the FROZEN image as the ROLLBACK image. Percent intramuscular fat was determined by chemical extraction on a *longissimus dorsi* sample from all animals, statistics were calculated for both FROZEN and ROLLBACK images relative to chemically determined percent intramuscular fat measures. FROZEN images had a mean of 5.87%, and s.d. of 1.21%. ROLLBACK images had a mean of 6.15% and s.d. of 1.25%. FROZEN images had a bias of 0.76%, correlation of 0.68, and standard error of prediction (SEP) of 1.20% relative to chemical percent intramuscular fat. ROLLBACK images had a bias of 1.04%, correlation of 0.72, and SEP of 1.15% relative to chemical percent intramuscular fat. This study only quantified the impact of use of digital cineloop on image interpretation software predictions of percent intramuscular fat, this study did not look at independent placement of the box within independent images under the FROZEN and ROLLBACK image collection protocols. Intramuscular fat prediction models were developed using the FROZEN images, and this protocol should be followed whenever possible. This study was limited in size and further study is warranted.

Key Words: Ultrasound, Beef Quality, Prediction

117 The effect of DNA marker assisted selection for the Rendement Napole gene on carcass composition, while in conjunction with enhancement treatment for lean quality and sensory characteristics. C. C. Carr*, J. B. Morgan, S. D. Carter, and F. K. Ray, *Oklahoma State University, Department of Animal Science*.

Progeny (n=70) from unrelated DNA tested, Napole carrier Hampshire sires and DNA tested, Napole normal Yorkshire dams were genotyped for the segregating RN- allele via DNA marker-assisted methodology. All littermates were represented within the same harvest. All carcass fabrication was initiated at 48h postmortem. Anterior sections of each boneless loin from right carcass sides was not subjected to enhancement treatment, whereas the posterior section of the same loin was enhanced with a solution containing .5% NaCl and .5% Na tripolyphosphate to 110% of initial weight. Carrier individuals exhibited less 10th rib fat depth, and higher percent muscle values (P<0.05), compared to normal individuals. Successive postmortem pH assessment during rigor onset resulted in lower pH values from LD of carriers at 3, 6, 12, and 24h (P<0.05), and a tendency to have lower 48h pH values (P=0.062) compared to LD of normal animals. LD from carriers exhibited higher GP values, greater drip loss, higher Hunter a* values, and more desirable trained sensory scores for tenderness, connective tissue amount, and overall acceptability (P<0.05) than LD samples from normal animals. No genotype differences (P>0.05) were found between LD samples for Hunter L* or b* values. Semimembranosus from carriers exhibited higher purge loss, lower pH values and higher L* values (P<0.05) than normal samples. Enhanced LD samples exhibited higher drip loss, higher pH and lower L* values, along with higher trained sensory values for overall sample acceptability (P<0.05) compared to non-enhanced samples. These findings suggest that the Napole gene has positive effects for percent muscle and sensory characteristics, but detrimental affects for numerous assessments of technological lean quality, which were often further compounded when subjected to enhancement treatment.

Key Words: Rendement Napole, Enhancement Injection, Pork Quality

118 The effects of halothane sensitivity on carcass composition and meat quality in HAL-1843-free pigs. C. P. Allison*¹, R. C. Johnson², and M. E. Doumit¹, ¹Michigan State University, ²Farmland Foods.

The objectives of this study were to determine the incidence of halothane sensitivity in HAL-1843-free pigs and the relationships between halothane sensitivity, carcass composition and meat quality. In Trial I, pooled semen from a commercial sire line was used to inseminate four commercial dam lines (A = S1 x D1, B = S1 x D2, C = S1 x D3 and D = S1 x D4). In Trial II, semen from four commercial sire lines was used to inseminate a single dam line (D5) [E = S1 x D5 (same sire line as Trial I), F = S2 x D5, G = S3 x D5 and H = S4 x D5]. Pigs were subjected to a 3% halothane challenge test at approximately 9 weeks of age. In Trial I, the response to halothane was evaluated by visually assessing limb rigidity, blotching of the skin and muscle tremors. Halothane sensitivity (HS) was observed in 59% of the pigs based on the above criteria. To better characterize the response, a scoring system was developed to classify pigs into categories: HS-low (HS-L), HS-intermediate (HS-I) and HS-high (HS-H). Using this system, 24, 41 and 34% of the pigs in E and 40, 33 and 27% of the pigs in G were categorized as HS-L, HS-I and HS-H, respectively. In F, 13% of the pigs were HS-I and no HS-H pigs were observed. Likewise, 18% of the pigs were HS-I and 2% of the pigs were classified as HS-H in H. No consistent effects due to HS were observed on carcass composition or meat quality when pigs were rendered unconscious using carbon dioxide stunning. However, when pigs were subjected to more extensive handling, transport and harvested at a plant that utilizes electrical stunning, ultimate pH was lower and drip loss was higher in loin muscle from HS-H compared to HS-L pigs (P < 0.05). These data demonstrate that some pigs are sensitive to halothane anesthesia even in the absence of the known HAL-1843 polymorphism. Additionally, halothane sensitivity may be associated with inferior pork quality under certain antemortem or postmortem conditions.

Key Words: Halothane Sensitivity, Stress Susceptibility, Porcine Stress Syndrome

119 Relationship between glycolytic oscillations and pork color and water-holding capacity. N. L. Berry*, E. E. Helman, C. P. Allison, and M. E. Doumit, *Michigan State University*.

The objective of this study was to determine if differences exist in the pattern of glycolysis in muscle extracts from superior and inferior quality pork loins. Characteristics of superior (n=6) and inferior (n=6) quality loins, respectively, were as follows: 45 min pH (6.40 ± 0.06 vs 5.92 ± 0.10), percent fluid loss after centrifugation (10.22 ± 0.47 vs 20.70 ± 0.32), percent drip-loss by the suspension method (0.66 ± 0.08 vs 3.23 ± 0.45), and day 1 L* (51.37 ± 0.66 vs 56.68 ± 0.86). Longissimus muscle samples were obtained at 20 min postmortem and were immediately frozen in liquid nitrogen and stored at -80° C until analysis. Samples were homogenized in 90 mM potassium phosphate, pH 6.5, and 180 mM potassium chloride, then centrifuged at 31,000 x g for 10 min. The resulting supernatant was centrifuged at 85,000 x g for 30 min. The high-speed supernatant was gel-filtered using Sephadex G-25 resin, and fractions containing sarcoplasmic proteins were collected and pooled. Glycolytic reaction mixtures contained 4 mM aspartate, 10 mM glucose, 7.5 mM orthophosphate, 25 mM imidazole, pH 6.9, 8.3 mM magnesium chloride, 0.2 mM calcium chloride, 1 mM ATP, 0.3 mM GTP, 0.1 mM NAD, and 1 mg muscle protein/mL. Glycolysis was initiated by the addition of 0.06 U/mL hexokinase, and was monitored for 46 min. Aliquots of reaction mixture were removed every 2 min and acidified to halt glycolytic activity. Enzymatic assays were used to quantify concentrations of ADP, ATP, and lactate. An oscillatory pattern of glycolysis was observed using extracts from both superior and inferior quality pork. No differences in the average ATP:ADP ratio or the overall mean concentrations of lactate or adenine nucleotides were observed in reactions using extracts from superior and inferior quality samples (P > 0.05). Thus, sarcoplasmic protein extracts do not appear to produce distinct patterns of glycolysis that are associated with differences in pork quality. However, this system will permit identification of specific metabolites that cause differences in the pattern of postmortem glycolysis.

Key Words: Glycolysis, Oscillation, Pork Quality

120 Effect of conjugated linoleic acid on pig growth and pork quality. A. D. Cox*, A. P. Schinckel, B. T. Richert, and M. A. Latour, *Department of Animal Sciences, Purdue University*.

A study was conducted to investigate the ability of conjugated linoleic acid (CLA) to alter pig growth performance and pork product quality during the last fourteen or twenty-eight days of the finishing period. Forty-two barrows from a single source were used. Six pigs were slaughtered upon arrival to obtain baseline data. The remaining thirty-six pigs were individually penned and then equally and randomly assigned to control, 0.5% CLA and 1.0% CLA diets. The pigs were sampled at fourteen and twenty-eight days of feeding. Eighteen animals (six per treatment) were processed on each sampling day (fourteen and twenty-eight) and carcass differences were evaluated. There were no differences in body weight or average daily gain. However, pigs fed CLA across both feeding periods had lower feed conversion ratios (2.43 vs. 2.83, P < 0.05) than control pigs. No overall affect on pork quality was observed except for belly firmness. By combining the two CLA treatment groups, a clear trend was observed in belly firmness (4.04 cm vs. 3.10, P < 0.09) which was determined by measuring the average bend of each sample. Belly weight between CLA versus control was not different (P < 0.19), but there is a tendency of increased belly weight in the CLA fed pigs compared with the control (2.27 kg vs. 2.40 kg). Although these data represent a small population, a clear trend in belly firmness was observed.

Key Words: Belly Firmness, CLA, Pigs

121 Essential fatty acids do not diminish the coconut oil enhancement of CLA-induced body fat loss. K. M. Hargrave* and J. L. Miner, *University of Nebraska*.

Dietary conjugated linoleic acid (CLA) causes a rapid loss of body fat in mice. This effect may depend on dietary supply of essential fatty acids (EFA). Mice fed a diet deficient in EFA, containing coconut oil (CO), exhibit enhanced response to CLA. We now report the effect of supplementing CO with specific EFA on CLA-induced body fat loss.

Male mice (n = 240) were blocked by body weight at weaning (3 wk of age) and randomly allotted to soy oil (SO) or CO diets for 42 d. Half of each group of mice was supplemented with 0.5% CLA isomers for an additional 14 d. CO-fed mice were supplemented with 0 or 1% linoleic acid, 0.1% linolenic acid, or 0.05% arachidonic acid for 2 d prior to, and during, the inclusion of CLA. Body weight and feed intake were measured weekly. Body fat and lean mass were determined with dual x-ray densitometry (PIXImus). CO and EFA did not alter feed intake, body weight, body fatness, or lean mass compared to SO. CLA supplementation reduced ($P < 0.05$) feed intake and body weight during the final 2 wk. CLA addition to the SO and CO diets reduced ($P < 0.001$) body fat by 8.7 and 24.4%, respectively. The addition of EFA did not alter body fat in CO-fed mice regardless of CLA inclusion. The weights of fat pads were reduced ($P < 0.05$) by CLA feeding, with the response greater in CO-fed mice regardless of EFA addition. Lean mass was not different between mice fed any of the diets. Liver weight was increased ($P < 0.001$) by CLA supplementation in mice fed CO, linolenic acid, and arachidonic acid but not in mice fed SO or linoleic acid. In summary, the addition of individual EFA did not alter the CO-enhanced loss of body fat in response to CLA. Therefore, the effect of CO sensitizing mice to CLA may be mediated by a mechanism independent of an EFA deficiency.

Key Words: Conjugated Linoleic Acid, Body Fat, Essential Fatty Acids

122 Effect of varying stocking density and split-marketing pen groups on pigmeat output. M.K. O'Connell^{1,2}, P.B. Lynch¹, and J.V. O'Doherty², ¹Teagasc, Ireland, ²University College Dublin, Ireland.

Two experiments were conducted to determine if pigmeat output could be increased by varying the stocking density of fixed size pens or split-

marketing pen groups. In experiment 1, single sex groups (n=30) were allotted at random to one of three treatments in an RCB design. Treatments were 1pig/m², 1.18pigs/m² and 1.36pigs/m², achieved by penning 11, 13 and 15 pigs in each pen (11.0m²). A standard pelleted diet was fed ad libitum (CP 188g/kg, CF 33g/kg, DE 13.6MJ/kg, dig. lysine: DE 0.69g/MJ). The trial period was from 35 to 95kg. In experiment 2, twenty-six single sex groups were assigned at random to one of three treatments: selling the entire pen group on one day (1D), selling the pen group on two days, 14d apart (2D) and selling the pen group over three days, 7d apart (3D). Pigs were fed the same diet as in experiment 1 as a wet mix (3: 1 water: feed). Performance of pigs (growth rate (ADG g/d), daily feed intake (g/d), feed conversion ratio (FCR kg/kg), carcass lean (g/kg) and pigmeat output per unit area (kg carcass per m² per year) were calculated for both experiments. Output per year was based on daily output*365*0.90 (0.90 occupancy rate) in experiment 1 and on cycle length (no. days until the last pig left pen plus 3d for refilling) in experiment 2. Results indicated no significant treatment differences in performance or carcass characteristics of pigs in either experiment ($P > 0.05$). Pigs stocked at 1.36pigs/m² had greater carcass gains (301 vs. 225 and 268kg/m²/yr, $P < 0.001$) per year than those stocked at 1pig/m² or 1.18pigs/m². Within pen variation in cold weight decreased with increased sale days (cv = 5.27, 3.81 and 1.74 %; $P < 0.001$). Cycle length increased (67.7, 75.9 and 76.7d; $P < 0.001$) for 1D, 2D and 3D respectively. Annual output per unit area was greatest when pigs were sold on a single day (carcass gains: 367, 328 and 327 kg/m²/yr, $P < 0.01$, for 1D, 2D and 3D, respectively). Pigmeat output was increased by increasing stocking density (within the range examined) and by selling pen groups on a single day.

Key Words: Pigs, Split-Marketing, Stocking Density

Nonruminant Nutrition

125 The essentiality of nonessential amino acids in low protein diet formulations for 11 to 30 kg barrows. D. C. Kendall^{*1}, R. W. Fent¹, J. L. Usry², and G. L. Allee¹, ¹University of Missouri, ²Ajinimoto Heartland LLC.

Three experiments were conducted to evaluate nonessential amino acids (NEAA) in low protein diets for 11 to 30 kg barrows (PIC C-23). In Exp. 1, 42 barrows (BW = 13.5 kg) were allotted to two treatments in a randomized complete block design (RCB) with 7 replicate pens of 3 pigs. The two corn-soy diets contained 0.80% L-Lys HCl and 1.10% TID lys, fortified with additional amino acids to maintain minimum ratios, with or without the further addition (1.49%) of a 50:50 mixture of L-Gln and L-Gly (GG). The addition of GG resulted in greater ADG (551 vs. 614 g/d; $P < .005$) and improved G:F (524 vs. 568 g/kg; $P < .03$). Experiment 2 was conducted to determine the optimal level of GG necessary to maximize performance. Sixty individually housed barrows (BW = 9.8 kg) were allotted to six treatments in a RCB with 10 replicate pens. Dietary treatments consisted of a five-point titration with GG (0.0 to 3.0%) replacing cornstarch in the basal diet from Exp. 1 (0.80% L-Lys HCl, 1.10% TID lys) and a control diet (0.20% L-Lys HCl, 1.10% TID lys). There were quadratic improvements in ADG (314, 343, 402, 418, and 411 g/d; $P < .05$) and linearly increasing G:F (519, 542, 611, 636, and 650 g/kg; $P < .001$) with increasing GG. However, performance was still below that of the control fed pigs ($P < .05$). Experiment 3 was conducted to test the source of nonessential nitrogen. Sixty individually housed barrows (BW = 12.9 kg) were allotted to six treatments in a RCB with 10 replicate pens. Treatments were GG (2.25%), glutamic acid (2.25%; GLUw) replacing GG on an equal weight basis, glutamic acid (4.5%; GLUn) or urea (0.94%) formulated isonitrogenous to GG, and a control diet. Each was replacing cornstarch in the basal diet from Exp. 2. Similar ADG was observed for pigs fed GG, GLUw and GLUn diets, but G:F was lower in GLUw diets ($P < .05$). Each had improved performance compared to the basal and urea supplemented diet ($P < .05$) but were lower than control fed pigs ($P < .05$). These experiments demonstrate that certain NEAA are required in corn-soy diets containing high levels of L-Lys HCl, but they cannot be supplied by nonprotein nitrogen.

Key Words: Pigs, Nonessential Amino Acids, Growth

127 Estimation of the ideal ratio of sulfur amino acids:lysine in diets for nursery pigs weighing 7 to 17 kilograms. A. M. Gaines^{*1}, G. F. Yi², B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, and C. D. Knight², ¹University of Missouri, ²Novus International Inc.

The objective of this research was to evaluate the ideal ratio of sulfur amino acids:lysine (SAA:LYS) for 7 to 17 kg pigs using both DL-methionine and Alimet[®] feed supplement as methionine sources. In Exp. 1, a total of 1,050 nursery pigs (PIC 337 × PIC C-22; 7.1 ± 0.19 kg) were allotted to one of five dietary treatments in a complete randomized design with six replicate pens per treatment. Dietary treatments included five different total SAA:LYS ratios: 48.9, 53.5, 58.1, 62.6, & 67.2%, respectively. Diets were formulated at a 1.55% total lysine and dietary sulfur amino acid content was increased by adding DL-methionine. In Exp. 2, a total of 1,549 nursery pigs (TR4 × C22; 8.3 ± 0.08kg) were allotted to one of nine dietary treatments in a randomized complete block design with eight replicate pens per treatment. The control diet (Diet 1) was formulated to contain 1.32% true ileal digestible lysine (TID) with no supplemental DL-methionine or Alimet[®] feed supplement (47.7% TID SAA:LYS). Diets 2-9 consisted of the control diet supplemented with four levels of DL-methionine or Alimet[®] feed supplement that corresponded to TID SAA:LYS ratios of 52.7, 57.7, 62.7, and 67.7%, respectively. In Exp. 1, increasing the total SAA:LYS ratio improved (quadratic, $P = 0.02$) G/F (0.710, 0.729, 0.741, 0.745, and 0.719) and resulted in numerical improvements (linear, $P = 0.22$) in ADG (463, 467, 481, 490, and 481 g/d). In Exp. 2, increasing the TID SAA:LYS ratio increased (quadratic, $P = 0.12$) ADG (448, 454, 462, 463, and 451 g/d) and improved (linear, $P = 0.01$; quadratic, $P = 0.01$) G/F (0.731, 0.754, 0.767, 0.762, and 0.759). There was no effect of methionine source ($P > 0.41$) and (or) methionine source × SAA:LYS interactions ($P > 0.33$) for ADG, ADFI, or G/F. Based on the results of the two experiments, the ideal ratio of SAA:LYS was estimated to be 62.6% (total basis) or 57.7% (TID basis) for 7 to 17 kg pigs.

Key Words: Sulfur Amino Acids, Pigs, Growth

128 Effects of increasing crystalline amino acids and the subsequent change in diet net energy on growing pig performance. N. Z. Frantz^{*1}, M. D. Tokach¹, M. U. Steidinger², S. S. Dritz¹, J. M. DeRouchey¹, R. D. Goodband¹, J. L. Nelssen¹, and J. L. Ury³, ¹Kansas State University, ²Anchor, ³Ajinomoto-Heartland LLC.

Three growth trials were conducted to evaluate the effect of increasing crystalline amino acids as a replacement for soybean meal (SBM) in diets for 10-20 kg pigs. A second objective was to determine if increasing dietary net energy as a result of increased crystalline amino acids and less SBM would influence growth. In all studies, pigs were fed a corn-SBM diet, or diets with 0.1, 0.2, 0.3, or 0.4 % L-lysine HCl and other amino acids (threonine and methionine) to maintain appropriate minimum ratios. There were 6 replicates per treatment in each trial and 48, 48, and 42 pigs per experimental unit in Exp. 1, 2, and 3, respectively. A total of 1,440 pigs (9.6 kg and 40 d of age) were used in Exp. 1 and 2 with 1,260 pigs (11.3 kg and 40 d of age) used in Exp. 3. Diets contained 1.36, 1.36, and 1.29% true ileal digestible lysine in Exp. 1, 2 and 3, respectively. In Exp. 1 and 3, added fat was constant at 1%. In Exp. 2, added fat was reduced slightly as amino acids replaced SBM to maintain constant ME levels. In Exp. 1, increasing crystalline amino acids had no effect on ADG, but improved (linear, $P < 0.05$) feed efficiency (G/F). In Exp. 2, ADG tended (linear, $P < 0.09$) to increase and G/F improved (quadratic, $P < 0.04$) with increasing crystalline amino acids. In Exp. 3, ADG and ADFI tended ($P < 0.09$) to increase with increasing crystalline amino acids, but G/F was unchanged. These results indicate that up to 0.4% L-lysine HCl with L-threonine and DL-methionine added to maintain proper ratios relative to lysine can replace SBM in a corn-SBM based diet for 10 to 20 kg pigs. Our results also demonstrate that the NE content of the diet increases as more crystalline amino acids are added. These data indicate that the ME values of NRC (1998) underestimate the energy value of diets containing high levels of crystalline amino acids.

Key Words: Pigs, Energy, Amino Acids

129 Effects of poultry meal source on nursery pig performance. T. P. Keegan^{*}, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz, and C. W. Hasted, Kansas State University.

Two experiments were conducted to determine the effects of poultry meal in nursery pig diets on growth performance. In Exp. 1, 210 pigs (initially 7.4 kg and 21 ± 2 d of age) were fed one of five diets: 1) control with no specialty protein products, or the control with: 2) 2.5% fishmeal; 3) 5.0% fishmeal; 4) 2.9% poultry meal; or 5) 5.9% poultry meal. Poultry meal (11.8% ash) replaced fishmeal on an equal lysine basis. From d 0 to 28, pigs fed fishmeal had greater ($P < 0.05$) ADG than the pigs fed the control diet or diets containing poultry meal. Increasing fishmeal tended to increase (quadratic, $P < 0.10$) ADG. Pigs fed fishmeal had improved ($P < 0.05$) feed efficiency (G/F) compared to pigs fed diets containing poultry meal. In Exp. 2, 350 pigs (initially 8.9 kg and 22 ± 2 d of age) were fed one of seven experimental diets: 1) control diet with no specialty protein products, or the control with: 2) 2.5% fishmeal; 3) 5% fishmeal; 4) 2.9% low ash poultry meal; 5) 5.8% low ash poultry meal; 6) 3.1% high ash poultry meal; or 7) 6.2% high ash poultry meal. Analyzed ash content for the low and high sources of poultry meal was 10.9 and 13.5%, respectively. Poultry meal replaced fishmeal on an equal lysine basis. From d 0 to 15, there was no difference in ADG or ADFI. However, pigs fed fishmeal or poultry meal had improved ($P < 0.05$) G/F compared to pigs fed the control diet. Pigs fed diets with low ash poultry meal had improved ($P < 0.05$) G/F compared to pigs fed diets with high ash poultry meal. Increasing fishmeal or poultry meal in the diet improved (linear, $P < 0.05$) G/F. These results indicate poultry meal cannot entirely replace fishmeal in nursery diets without a reduction in performance. Quality control specifications, such as ash content, need to be considered when using poultry meal as an animal protein ingredient in nursery pig diets.

Key Words: Nursery Pig, Poultry Meal, Fishmeal

130 Evaluation of Illinois Bundle Flower by digestibility and nitrogen balance as a protein supplement for young pigs. S. K. Baidoo^{*} and Q. M. Yang, University of Minnesota.

The reestablishment of a native perennial legume, such as Illinois Bundle Flower (*Desmanthus illinoensis*) cover on retired cropland can reduce soil erosion, increase root turnover and increase accumulation of surface litter. The objective of this study was to determine the optimum inclusion rate of IBF in young pig diets. Twenty four 18-d old early-weaned pigs (6.2 ± 0.3 kg BW) were randomly allotted to 3 dietary treatments to study the effect of Illinois Bundle Flower (IBF) on feed digestibility and nitrogen balance in young pigs. Corn-soybean meal (SBM) basal diets with 0, 5% and 10% IBF were used for Phases 1 (d 1 - 14) and 2 (d 15-28) after weaning. Nutrient digestibility and nitrogen balance were determined using chromium oxide as indigestible marker. Supplementation of IBF at 10% decreased ($P < 0.05$) the digestibility of nitrogen (N) in Phase 1 and the digestibility of DM, N, P and crude ash in Phase 2. However, the digestibility in pigs fed diets with 5% IBF was not different from the control diets ($P > 0.05$) in both Phases 1 and 2. Nitrogen excretion increased with increase in IBF in the diets. Compared to the control diet, the increase in total N excretion or the decrease in N retention were 4.5% and 13.7% in Phase 1, and 1.9% and 5.0% in Phase 2 for the 5% and 10% IBF diets, respectively. The diet with 10% IBF increased N excretion in both feces and urine, but the diet with 5% IBF only increased N excretion in urine compared to control diet in Phase 1 ($P < 0.05$). Nitrogen retention ratios decreased with increase in IBF in the diets ($P < 0.05$). In Phase 2, the diet with 10% IBF increased N excretion in feces. However, urinary N: fecal N was lower ($P < 0.05$) for the diet with 10% IBF compared to control and 5% IBF diets. In summary, the supplementation of IBF at 10% decreased N digestibility and retention in Phase 1, and decreased the digestibility of N, P, DM, and ash in Phase 2. Based on the results of this study, 5% IBF included in the diets of young pigs did not affect nutrient digestibility and nitrogen retention.

Key Words: Piglets, Illinois Bundle Flower, Digestibility

131 Effect of Illinois Bundle Flower on the performance of young pigs. Q. M. Yang^{*}, S. K. Baidoo, and G. He, University of Minnesota.

Illinois Bundle Flower (IBF) (*Desmanthus illinoensis*) is a perennial native legume that produces high seed yields and has a potential as a protein supplement in young pig diets. The objective of this study was to determine the optimum inclusion rate of IBF in young pig diets. A total of 32 pigs (6.0 ± 0.4 kg BW) were randomly allotted to 4 dietary treatments with 2 pigs/pen and 4 pens/treatment to study the effect of Illinois Bundle Flower (IBF) on the performance of early-weaned pigs. Pigs were allotted to 1.2 m by 1.6-m raised-deck pens with plastic-coated floor at random by litter and initial weight. Pig weight and feed disappearance were determined at the end of Weeks 1, 2 and 4. Corn-soybean meal (SBM) basal diets with 0%, 5%, 10% and 20% IBF were fed in Phases 1 (d 1 - 14) and 2 (d 15 - 28) after weaning. The inclusion of IBF was substituted for SBM. Diets were iso-nitrogenous and iso-caloric. Increased in IBF in the diet resulted in a decline in weight gain in Wk 1 (179, 150, 115 and 114 g/d) Wk 2 (537, 473, 434, 379 g/d) and Wk 3-4 (599, 599, 543 and 554 g/d) for 0%, 5%, 10% and 20% IBF diets, respectively. The corresponding feed intakes were for Wk 1 (206, 166, 162 and 160 g/d), Wk 2 (600, 467, 484 and 475 g/d), and Wk 3-4 (777, 714, 715 and 657 g/d) for 0%, 5%, 10% and 20% IBF diets, respectively. The average feed efficiency (Gain:Feed) decreased by 4.8% for the diets with both 10% and 20% IBF, but was improved by 7.2% for the diet with 5% IBF compared to the control diet. The overall (Wk 1-4) ADG was 478, 455, 409 and 400 g and the ADFI was 590, 515, 519 and 487 g and the gain:feed was 0.83, 0.89, 0.79 and 0.79 for the diets with 0%, 5%, 10% and 20% IBF, respectively. In conclusion, 5% IBF in the diets of young pigs did not affect the overall performance during the 28-d study.

Key Words: Piglets, Illinois Bundle Flower, Growth Performance

132 Replacement of fishmeal with *Amino Balance*TM in diets for 5-10 kg pigs. J. D. Hahn*, S. A. Hansen, and B. V. Lawrence, *Hubbard Feeds, Inc.*

Performance effects from feeding Phase 1 (P1) and Phase 2 (P2) nursery diets containing a proprietary protein blend, *Amino Balance*TM (AB), as a replacement for fishmeal, were evaluated. Initially 1008 PIC pigs (C22 x TR4) weighing 5.4 kg ± .02 kg were allotted to two treatments (n=18), in a conventional nursery at 28 pigs/pen. The feeding program utilized a 1.50% Lys P1 and a 1.40% Lys P2 diet from 0-7 days and 8-18 days post-weaning, respectively. The control (CONT) was P1 and P2 diets containing 11% and 6.5% fishmeal, respectively. The experimental (EXP) regimen was P1 and P2 with 12.5% and 9.0% AB, respectively. During the 0-7 day period, the ADG, ADFI, and GF were 178 vs. 186 g/d, 148 vs. 161 g/d, and 1.21 vs. 1.16 g/g for the CONT and EXP regimens, respectively. During the 0-18 day period, the ADG, ADFI, and GF were 251 vs. 248 g/d, 273 vs. 277 g/d, and 0.92 vs. 0.89 g/g for the CONT and EXP regimens, respectively. The EXP regimen increased (P < 0.05) ADFI in the 0-7 day period, but all other parameters were not effected (P > 0.10). In Trial 2, 1000 terminal cross pigs (Duroc x Large White/Landrace) weighing 5.8 kg ± .02 kg were allotted to CONT and EXP regimens (n=20), in a conventional nursery, at 25 pigs/pen. The same feeding program was utilized, with the exception that the P2 diet was fed from 8-21 days post-weaning. The CONT was P1 and P2 diets with 4.5% and 3.5% fishmeal, respectively. The EXP regimen was P1 and P2 with 6.5% AB. During the 0-7 day period, the ADG, ADFI, and GF were 77 vs. 104 g/d, 112 vs. 132 g/d, and 0.73 vs. 0.83 g/g for the CONT and EXP regimens, respectively. During the 0-21 day period, the ADG, ADFI, and GF were 265 vs. 277 g/d, 319 vs. 324 g/d, and 0.83 vs. 0.86 g/g for the CONT and EXP regimens, respectively. EXP regimen increased (P < 0.05) ADG and ADFI for the 0-7 day period. EXP regimen increased ADG (P < 0.05) and GF (P < 0.08) for the 0-21 day period. In these trials, substitution of *Amino Balance*TM for fishmeal produced no negative effects on nursery pig performance.

Key Words: Nursery Pigs, Growth, Fishmeal

133 Effect of diets containing mycotoxins with or without Mycosorb[®] on piglet performance. S. W. Casteel¹, L. W. Pace¹, G. E. Rottinghaus¹, T. J. Evans¹, and P. Spring², ¹University of Missouri ²Swiss College of Agriculture, Switzerland.

The purpose of this experiment was to determine the effect of diets containing mycotoxins with or without Mycosorb[®] on piglet performance. Fifty piglets 7-days post weaning were assigned to 10 treatment groups. The trial lasted 14 days. Feed and water were provided ad libitum. Starter (S-2) diets meeting NRC nutrient requirements were fed as mash. Diets contained no toxin, aflatoxin (0.5 ppm), deoxynivalenol (DON, 5 ppm), zearalenone (ZEA, 4 ppm) or a combination of the 3 toxins. Each diet was tested with 2 levels (0 and 0.2%) of Mycosorb[®] (Alltech Inc.). Performance of the piglets was measured and external appearance was described. Statistical comparisons were performed using a one-way ANOVA, and pair-wise comparisons were made using a t-test. For statistical analysis, relative growth rates (% of body mass/day) were calculated as (weight gain (kg/day)/initial body weight (kg) * 100). Only those piglets fed diets containing 3 mycotoxins (aflatoxin, DON and ZEA) or DON alone had reduced relative growth rates from the control (P < 0.05). The relative growth rate of the pigs fed DON with Mycosorb[®] was increased compared to the animals fed the control diet (P < 0.07); however, it was not statistically different from the DON only group. Pigs fed a combination of aflatoxin, DON and ZEA with Mycosorb[®] grew better than those pigs fed the same combination of mycotoxins without the adsorbent (P < 0.05). DON and the combination of aflatoxin, ZEA and DON led to a reduction in growth rate compared to the control. Mycosorb[®] alleviated some of the negative effects of a combination of aflatoxin, ZEA and DON on growth.

Key Words: Mycotoxin, Pig, Growth

134 Influence of dietary δ -aminolevulinic acid supplementation on growth performance and hematological changes in weaned pigs. B. J. Min¹, I. H. Kim¹, J. W. Hong^{*1}, O. S. Kwon¹, W. B. Lee¹, K. S. Shon¹, J. H. Cho¹, and J. H. Kim², ¹Dankook university, Korea, ²Agribands Purina Korea, Inc.

This study was conducted to investigate the effects of δ -aminolevulinic acid supplementation on growth performance, nutrient digestibility and hematological changes in weaned pigs. Seventy five LYD pigs (7.21±0.02kg average BW) were used in a 20 d growth assay. Dietary treatments included: 1) NC (negative control; basal diet), 2) PC (positive control; NC diet+0.1% Apramycin+0.1% oxytetracycline, antibiotics), 3) ALA0.1 (NC diet+0.1% δ -aminolevulinic acid, EnviroVax[®], EnBioGene Inc.), 4) ALA0.2 (NC diet+0.2% δ -aminolevulinic acid) and 5) ALA+AB (PC diet+0.2% δ -aminolevulinic acid). In entire experimental period, ADG was greater for pigs fed ALA+AB diet than for pigs fed NC diet (P<0.05). However, there was no difference in ADG for pigs fed PC, ALA0.1 or ALA0.2 diets. Also, ADFI and Gain/Feed were not affected by treatments. On d 20, digestibilities of DM and N were higher (P<0.05) for pigs fed ALA+AB diet than for pigs fed NC and ALA0.1 diets. Total protein concentration of serum was increased in ALA+AB treatment compared to NC and PC treatments (P<0.05). In iron concentration of serum, pigs fed δ -aminolevulinic acid supplementation diets were greater than for pigs fed NC and PC diets (P<0.05). TIBC concentration of serum was increased in ALA+AB treatment compared to NC, PC and ALA0.1 treatments (P<0.05). Pigs fed ALA+AB and ALA0.2 diets had higher hemoglobin (Hb) and hematocrit (HCT) concentration of blood than pigs fed NC and PC diets (P<0.05). RBC and WBC concentrations of blood were higher (P<0.05) for the pigs fed ALA0.2 and ALA+AB diets than for pigs fed NC diet. Lymphocyte concentration of blood was increased in δ -aminolevulinic acid supplementation treatment compared to NC treatment (P<0.05). In conclusion, δ -aminolevulinic acid and antibiotic mixture supplementation may result in greater effective growth performance in weaning pigs.

Key Words: Pigs, δ -Aminolevulinic Acid, Growth Performance

135 Evaluation of Hemicell[®] on growth performance of late nursery pigs. N. A. Lenehan*, R. D. Goodband, M. D. Tokach, J. M. DeRouchey, J. L. Nelssen, S. S. Dritz, C. N. Groesbeck, C. W. Hastad, T. P. Keegan, K. R. Lawrence, and M. G. Young, *Kansas State University* .

A total of 276 pigs (initially 9.9 kg) were used to determine the effects of added Hemicell[®] on growth performance in a 19-d growth assay. Hemicell[®] is a patented fermentation product of *Bacillus lentus*. The active ingredient in the fermentation product is β -mannanase. However, other enzymes such as amylase, xylanase, cellulases, and α -galactosidase also are present. The proposed mechanism for Hemicell[®] is that it degrades β -mannan in feed, thus, removing its effects as an anti-nutritive factor in swine diets. Dietary treatments were arranged as a 2 x 3 factorial, with or without 0.05% Hemicell[®], in diets with 3 energy densities (3,060, 3,280, 3,501 ME, kcal/kg). The 100 kcal increments were achieved by the addition of wheat bran or soy oil to a corn-soybean meal based diet. There were 6 pigs per pen and 5 pens per treatment. There were no Hemicell[®] x dietary energy interactions (P > 0.12). Increasing energy density of the diet resulted in a quadratic (P < 0.03) improvement in ADG (456, 492, and 481 g/d) and feed efficiency (G/F; 0.67, 0.71, and 0.71). The addition of Hemicell[®] to the diets, regardless of energy level, did not improve (P > 0.60) ADG (478 vs 475), ADFI (685 vs 686), or G/F (0.70 vs 0.69) compared to those pigs fed diets with no added Hemicell[®]. In conclusion, increasing the energy density of the diet improved pig performance; however, Hemicell[®] did not influence pig performance.

Hemicell:	Without			With			
ME Kcal/kg:	3060	3280	3501	3060	3280	3501	SE
ADG, g	445	503	476	467	481	485	0.03
ADFI, g	671	712	676	694	689	671	0.04
Gain:feed	0.66	0.71	0.70	0.67	0.70	0.72	0.02

Key Words: Weaning Pigs, Energy, Enzyme

136 Comparison of different antimicrobials and antimicrobial alternatives on nursery pig performance. T. P. Keegan*, J. M. DeRouche, J. L. Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz, and C. W. Hasted, *Kansas State University*.

Three experiments were conducted to compare the effects of in-feed antimicrobials and alternatives on nursery pig performance. In Exp. 1, 720 pigs (5.8 kg and 18 ± 2 d of age) were fed one of eight diets in a research facility: 1) Control with no additives; 2) carbadox (55 mg/kg); 3) Lac-toSacc (0.2%); 4) Bio-Plus 2B (0.05%); 5) Bio-Mos (0.3%); 6) Probios (1.6% from d 0 to 14 and 0.8% from d 14 to 21); 7) BioSaf (0.3%); or 8) Biomate Yeast Plus (0.1%). In Exp. 2, 320 pigs (5.3 kg and 14 ± 2 d of age) were fed diets 1 thru 5 from Exp. 1 in a commercial facility. In Exp. 3, 320 pigs (4.9 kg and 14 ± 2 d of age) were fed in the same commercial facility as in Exp. 2 and diets included: 1) Control with no additives; 2) carbadox (55 mg/kg); 3) Denaguard/CTC (38 mg/kg tiamulin, 441 mg/kg chlortetracycline); 4) Neo-Terramycin (154 mg/kg neomycin sulfate, 154 mg/kg oxytetracycline HCl); or 5) Bio-Mos (0.3%). In Exp. 1, pigs fed the diet containing carbadox had increased ($P < 0.05$) ADG and feed efficiency (G/F) compared to pigs fed the control diet. There was no difference in performance between pigs fed all other diets and pigs fed the control diet ($P > 0.05$). In Exp. 2, pigs fed the control diet or the diet containing Bio-Mos had greater ($P < 0.05$) ADG and ADFI compared to pigs fed the diet containing Bio-Plus 2B, but none of the diets improved performance compared to the control ($P > 0.05$). Because a growth response to carbadox was not observed in Exp. 2, Exp. 3 was conducted to evaluate different antibiotics. Pigs fed Denaguard/CTC or Neo-Terramycin had greater ($P < 0.05$) ADG and ADFI compared to pigs fed the control diet. There was no difference between pigs fed the control diet or diets containing carbadox or Bio-Mos ($P > 0.16$). These results indicate that antibiotic alternatives did not consistently improve growth performance. The variation in response to the in-feed antimicrobial sources in Exp. 3 illustrates the need to determine the most appropriate antimicrobial on an individual farm basis.

Key Words: Nursery Pig, Yeast, Antimicrobials

137 Effect of dietary sodium chlorate on growth performance of weaned pigs. T. E. Burkey*, S. S. Dritz, and J. E. Minton, *Kansas State University*.

Addition of sodium chlorate (CHLOR) may offer an alternative to dietary antibiotics for nursery pigs. In the present study, we evaluated dietary CHLOR at 50, 100 or 200 ppm in a 31-d growth assay. Additional treatments included a negative control (CON) with no added antimicrobial, and a positive control with added carbadox (CARB) at 50 ppm. Weaned, crossbred barrows and gilts ($n=240$; 6.4 ± 0.8 kg initial weight) were blocked by sex and weight at weaning and allotted to one of five dietary treatments. 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 31) diets. The performance parameters of ADG, ADFI and F:G were calculated and analyzed corresponding to feeding phase. ADG during phase I was 260, 260, 230, 250 and 270 ± 1 g/d and during Phase II was 600, 620, 600, 590 and 600 ± 2 g/d for CON, 50, 100, 200 ppm CHLOR, and CARB, respectively, and was not significantly affected by treatment. Similarly, neither ADFI or G:F were affected by treatment in either phase. In general, dietary antibiotics improve growth performance in nursery pig environments where pathogen load may impede pig growth. However, CARB did not stimulate a growth response in the current study. Therefore, a beneficial effect of CHLOR on nursery pig growth cannot be ruled out in nursery environments that also elicit a growth response to dietary antibiotics.

Key Words: Sodium Chlorate, Carbadox, Weaned Pigs

138 Effects of feeding levels and particle size of Biotite V^(r) on growth performance, nutrient digestibility and fecal NH₃-N and volatile fatty acids in nursery pigs. W. B. Lee¹, I. H. Kim^{*1}, J. W. Hong¹, O. S. Kwon¹, B. J. Min¹, K. S. Shon¹, J. H. Cho¹, and Y. K. Jung², ¹Dankook University, Korea, ²Seobong Biobestech Co., Ltd, Korea.

This experiment was conducted to investigate the effect of Biotite V^(r) (BT) on growth performance, nutrient digestibility and fecal gas emission in pigs. A total of 100 nursery pigs (initial body weight 13.12 ± 0.15 kg) were used in a 21-d growth assay. The five treatments were:

control (CON, basal diet), BT0.5-200 (basal diet + 0.5% BT, 200mesh), BT1.0-200 (basal diet + 1.0% BT, 200mesh), BT0.5-325 (basal diet + 0.5% BT, 325mesh) and BT1.0-325 (basal diet + 1.0% BT, 325mesh). Each treatment had four replicates with five pigs per replicate. ADG, ADFI, gain/feed and nutrient digestibility were not different among the treatments ($P > 0.05$). Fecal NH₃-N concentration of pigs fed the BT325 diets was lower than that of pigs fed the BT200 diets ($P = 0.01$). The BT treatments reduced fecal volatile fatty acids compared to the CON (propionic acid, $P = 0.01$; butyric acid, $P = 0.01$; acetic acid, $P = 0.02$). Especially, fecal propionic acid concentration of pigs fed the BT325 diets was lower than that of pigs fed the BT200 diets ($P = 0.02$). In conclusion, the results obtained from this feeding trial suggest that dietary BT for nursery pigs has effects on fecal noxious gas emission.

Key Words: Pigs, Biotite, Noxious Gas Emission

139 Relative phosphorus bioavailability in growing pigs fed diets supplemented with phytase from transgenic alfalfa leaf meal or microbial sources. K. L. Saddoris* and T. D. Crenshaw, *University of Wisconsin-Madison*.

In earlier trials phytase expressed in transgenic alfalfa leaf meal (tAfP) improved P bioavailability in pigs and chicks more effectively than predicted from laboratory assays of phytase activity. In the current trial 72 pigs (~14 kg) were randomly assigned to one of 12 diets designed for slope-ratio comparisons of inorganic P (iP), microbial phytase (NP, Natuphos[®] 5000, BASF) and tAfP. Pigs were individually housed for the 4-wk trial. Treatments included corn-SBM diets fortified with iP (dicalcium phosphate) to 0.40, 0.45, 0.50, and 0.55% total P without phytase, or 0.40% P diets with NP (500, 750, and 1000 FTU/kg) or tAfP (80, 120, 160, 200, and 240 FTU/kg). Amounts of tAfP (150 FTU/g) ranged from 0.53 to 1.60 g/kg diet. The tAfP range was based on observations from earlier trials in which maximum P bioavailability responses to tAfP occurred at 200 FTU/kg diet. In addition to ADG, ADFI, and GF, bone mineral content (BMC) gain was calculated from DXA scans on d 0, 14, and 28 of the trial. Main effect responses of ADG, GF and BMC gain were improved ($P < 0.05$) among pigs fed iP and NP compared with those fed tAlf. Within iP and NP treatment groups, linear responses ($P < 0.01$) in BMC gain were observed as iP or NP levels increased, but a dose-response relationship was not detected ($P > 0.30$) in BMC gain of pigs fed tAfP. Over 28 d BMC gain was greater (9.36 g BMC/d) in pigs fed diets with NP at 1000 FTU/kg than pigs fed 0.40% iP diets (1.64 g BMC/d). Pigs fed tAfP to supply 240 FTU/kg failed to improve ($P > 0.20$) BMC gain (3.49 g/d) above that of pigs fed 0.40% iP diets (1.64 g/d). The failure to induce a dose response in BMC gain of pigs fed tAfP is not consistent with earlier trials and precludes inferences about relative phytase bioactivity between NP and tAfP sources. Based on results from this trial inferences about relative relationships between bioactivity of tAfP and laboratory assays could not be established.

Key Words: Swine, Phosphorus, Alfalfa

140 Effect of dietary natural herb extract (Biomate^(r)) supplementation on growth performance and meat quality in finishing pigs. O. S. Kwon^{*1}, I. H. Kim¹, J. H. Kim², J. W. Hong¹, B. J. Min¹, W. B. Lee¹, K. S. Shon¹, J. H. Cho¹, J. C. Ra³, and J. H. Kim³, ¹Dankook University, Korea, ²Agribands Purina Korea, Inc., ³RNL Life Science Ltd. Korea.

A total of 86 pigs (LYD, 72.1 kg average initial BW) were used in a 56-d growth assay to determine the effects of dietary natural herb extract (Biomate[®]) on growth performance and meat quality in finishing pigs. Dietary treatments included: 1) CON (basal control diet), 2) BM1 (basal diet plus 0.05% Biomate[®]), 3) BM2 (basal diet plus 0.10% Biomate[®]) and 4) BM3 (basal diet plus 0.20% Biomate[®]). Through the entire experimental period, pigs fed the BM1 diet had increased ADG compared to pigs fed the CON diet ($P < 0.05$). BM1 and BM3 diets supported higher gain/feed than the CON diet ($P < 0.05$). Backfat thickness appeared to decrease in pigs fed BM diets compared to pigs fed the CON diet, however there was no significant difference among the treatments ($P > 0.05$). Hunter L*, a* and b* values of longissimus muscle were not affected by the dietary treatments ($P > 0.05$). Marbling and firmness of longissimus muscle were not different among the treatments ($P > 0.05$). Pigs fed BM1 and BM3 diets had higher longissimus muscle color than pigs fed the CON diet ($P < 0.05$). In conclusion, the results obtained

from this feeding trial suggests that Biomate® supplementation of diets for finishing pigs may result in improved growth performance.

Key Words: Pigs, Herb Extract, Meat Quality

141 Effects of increasing calcium to total phosphorus ratio in diets containing phytase on finishing pig growth performance. S. M. Hanni*, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University*.

Our objective was to determine the effects of increased calcium to total phosphorus (Ca:P) ratio on growth performance of grow-finish pigs fed diets containing phytase. A total of 144 grow-finish pigs (72 barrows and 72 gilts; initially 38.6 kg) were blocked by weight and sex, and allotted to one of four dietary treatments. Each treatment had six replications per sex and two pigs per pen. Diets were corn-soybean meal-based and fed in three phases. In each phase, diets were formulated to have Ca:P ratios of 0.75:1, 1:1, 1.25:1, 1.5:1, or 2:1. A sixth treatment group (negative control) was fed a diet containing 77% of the total P of the other treatment diets. Diets were formulated to contain 0.44%, 0.38%, and 0.32% total P from 32 to 60, 60 to 89, and 89 to 110 kg, respectively. All diets contained 0.05% phytase from Natuphos, providing 300 FTU/kg. For the overall experiment, increasing Ca:P ratio decreased ADG (quadratic, $P < 0.04$) and feed efficiency (G:F; quadratic, $P < 0.004$) with the greatest decrease observed when Ca:P ratio increased from 1.5:1 to 2:1. Bone ash, ADFI, carcass weight, and backfat thickness was not affected by Ca:P ratio. Similar to the decreases in growth performance and carcass characteristics when Ca:P ratio was increased from 1.5:1 to 2:1, pigs fed the sixth treatment had a numerical decrease in ADG, G:F, final wt, and decreased ($P < 0.05$) backfat. In conclusion, these data suggest that diets containing 300 FTU/kg phytase should not have total calcium to phosphorus ratio of greater than 1.5:1 when fed to growing-finishing pigs.

Ca:P Ratio	Neg. Control	0.75:1	1:1	1.25:1	1.5:1	2:1	SED
ADG, kg	0.97	0.99	1.02	1.00	0.99	0.92	0.03
ADFI, kg	2.88	2.82	2.81	2.87	2.80	2.89	0.08
Gain/feed	0.34	0.35	0.36	0.35	0.35	0.32	0.01

Key Words: Calcium, Phosphorus, Pigs

142 Effect of magnesium sources on pork quality in finishing pigs. J. S. Lim, M. S. Yun*, C. S. Kong, and Y. Y. Kim, *Seoul National University*.

This experiment was conducted to evaluate the beneficial effects of various sources of magnesium on pork quality in finishing pigs (n=60; 121 kg BW; 4 pigs/pen). Treatments were: 1) a control basal diet, 2) basal + 0.12% MgSO₄, 3) basal + 0.12% MgCl₂, 4) basal + 0.12% MgO, and 5) basal + 0.12% magnesium gluconate (Mg-glu), respectively. The experimental diet and water were provided ad libitum for 5 days pre-slaughter. There were no differences on growth performance by Mg sources. When pigs were fed MgSO₄, muscle glycogen concentration was higher than other treatments ($P < 0.05$). No effect on muscle pH was found; however, Hunter L* value (40 min post-mortem) of control groups was lower than that of MgO or Mg-glu treatments ($P > 0.05$). Hunter a* value of the Mg-glu treatment was higher than other groups ($P > 0.05$). And Hunter b* values in control and MgSO₄ treatments were lower than MgO, MgCl₂ or Mg-glu treatments ($P > 0.05$). Blood cortisol level was not changed by Mg sources. But it showed that MgSO₄ supplementation in the finisher diet was an effective way to reduce stress response before slaughtering. While there were no significant differences among treatments on TBARS value, the value was the lowest when pigs were fed Mg-gluconate. Consequently, inorganic Mg (e.g. MgSO₄) is an effective source to influence pork color and muscle glycogen concentration while organic Mg (Mg-gluconate) may show a beneficial effect on reduction of pork oxidation.

Key Words: Magnesium Sources, Muscle Glycogen, Pork Quality

143 Chromium propionate influence on pig performance and meat quality. B. V. Lawrence¹, D. Overend¹, S. A. Hansen¹, J. D. Hahn¹, and R. Odgaard², ¹Hubbard Feeds Inc., ²Kemin Americas.

A total of 387 Duroc gilts (Compart Boar Store Line 442 X D100) weighing 32.5 ± 1.1 kg were allotted to one of three treatments: A corn-soybean meal control diet (CTRL), control diet + 200 ppb Cr from Kem-TRACE® Cr propionate (Cr), or the CTRL diet until 63-d and then the Cr diet (CTRL/Cr). Pigs were weighed on d-63 and 91. Day 0 to 63 gain was higher ($P < 0.05$) for the Cr fed pigs with a trend for increased intake ($P < 0.10$). There was no effect of Cr on G: F ($P > 0.10$). Day 63 to 91 gain was also higher ($P < 0.01$) for the Cr fed pigs, as was intake ($P < 0.10$). Day 63 to 91 G: F was not different ($P > 0.10$). At d-91, 80 gilts per treatment (116.2 ± 6.07 kg) were scanned via real-time ultrasound for 10th and last rib backfat and loin eye area. There was no effect ($P > 0.10$) of Cr supplementation on carcass composition. A total of 40 gilts per treatment, within a common weight range (122.3 ± 3.8 kg), were individually tagged and tattooed prior to shipment. After 8-h of transit to a commercial packer, live weights were obtained (119.1 ± 3.5 kg). Hot carcass weight (HCW) was also measured (91.6 ± 2.9 kg). Farm weight, packer live weight, HCW and fat and muscle depth as well as percent lean, were not different ($P < 0.10$). Loin pH at 1 and 22-h post-mortem was not different, however, there was a numerically ($P < 0.16$) lower loin 22-h pH decline for the Cr fed pigs compared to the CTRL (0.52 vs. 0.60 units). At 22-h a 40 - 50 g loin core was taken between the 7th and 8th ribs and held for 7-d for determination of drip loss. The reduction in 22-h pH decline was associated with a trend ($P < 0.10$) toward a reduction in 7-d drip loss (3.75 vs. 4.86%). NPPC measures of loin color, firmness, and marbling, as well as ColorTec L*, A*, and B* values were not different ($P > 0.10$) between the CTRL and Cr fed pigs. These results suggest that long-term Cr propionate supplementation may improve pig growth via stimulation of feed intake and may reduce drip loss via a reduction in the rate of post-mortem pH decline.

Key Words: Chromium Propionate, Meat Quality, Pigs

144 Effect of barley sample, particle size and enzyme supplementation on energy digestibility of barley fed to grower pigs. T. N. Nortey*¹, R. Hawkes^{1,2}, D. Overend³, M. D. Drew², J. F. Patience¹, M. Blair⁴, and R. T. Zijlstra¹, ¹Prairie Swine Centre Inc., ²University of Saskatchewan, ³Ridley Inc., ⁴Adisseo.

Variability in DE content of barley is caused by changes in energy digestibility that may be reduced by specific processing procedures, e.g., grinding and enzyme supplementation. Effects of three barley samples (B1, high; B2, medium and B3, low predicted DE using ADF), three particle sizes (fine, FPS; medium, MPS and coarse, CPS), and two enzyme treatments (control and -glucanase/xylanase) on energy digestibility and DE content were investigated in a 3 x 3 x 2 factorial arrangement. Diets included 96% barley and 0.4% chromic oxide. Pigs (30.9 ± 1.7 kg) were fed two different diets at 3 x maintenance in subsequent periods for 6 observations per diet. Grab fecal samples were collected for 5 d. Feed and feces were analyzed to determine apparent total-tract energy digestibility and DE. Energy digestibility was affected by barley sample ($P < 0.001$), particle size ($P < 0.001$), and sample x particle size ($P < 0.05$), but unlike previous studies, not by enzyme supplementation ($P > 0.10$). The diet DE content for B1, B2 and B3 were each different ($P < 0.001$; 3180, 2997 and 2567 kcal/kg DM, respectively), confirmed the predicted ranking, and followed changes in energy digestibility ($P < 0.001$; 74.3, 69.5 and 58.5%, respectively). Overall, the DE content for FPS was 3.4 and 4.2% higher than for MPS and CPS ($P < 0.001$; 2988, 2891 and 2866 kcal/kg DM, respectively), following changes in energy digestibility ($P < 0.001$; 69.2, 66.7 and 66.4%, respectively). Energy digestibility was similar for B2-FPS and B1-CPS, suggesting that reducing particle size for medium DE barley may reduce variation in DE content. The lack of enzyme response suggests that -glucans or xylans did not cause the reduced DE content for B2 and B3. Prediction of barley quality prior to processing and subsequent adjustments in processing may be components in a decision model to achieve a consistent diet DE content.

Key Words: Barley, Particle Size, Pig

145 Digestible tryptophan:lysine ratio in diets for finishing pigs. G.J.M.M. de Lima^{*1,2}, C. H. Klein¹, and L. Hackenhaar³, ¹EMBRAPA - Swine and Poultry National Research Center, Brazil, ²CNPq, Brazil, ³Ajinomoto Biolatina, Brazil.

This study was carried out to identify the best true ileal digestible tryptophan (DigTrp):lysine (DigLys) ratio for finishing swine fed diets based on corn, soybean meal and 10% animal byproducts, where tryptophan is the second limiting amino acid. Sixty barrows and sixty gilts, progeny of Embrapa MS60 terminal sire line and Large White x Landrace females, were used in a randomized block design according to a 2 X 5 factorial arrangement of treatments (sex X DigTrp:DigLys ratios). Five DigTrp:DigLys ratios were studied: 0.16, 0.17, 0.18, 0.19 and 0.20. Diets were calculated to provide 0.80% DigLys and meet or exceed NRC nutrient requirements. Different DigTrp:DigLys ratios were obtained by adding synthetic tryptophan in the place of caulin in the diet. Average initial and final weights were 76.24 ± 1.15 and 96.59 ± 1.33 kg, respectively. Interactions between sex and DigTrp:DigLys ratios were not significant ($P > 0.10$) for all studied variables. There were sex differences for all variables. Barrows showed the best growth performance ($P < 0.10$) and gilts had the best carcass quality ($P < 0.008$). DigTrp:DigLys ratios did not affect daily weight gain ($P = 0.53$), daily feed consumption ($P = 0.61$), feed conversion ($P = 0.90$) and all carcass variables ($P > 0.10$), according to F test. It was concluded that the best DigTrp:DigLys ratio for pigs fed diets based on corn, soybean meal and animal byproducts is 0.16 for the finishing phase.

Key Words: Tryptophan, Lysine, Swine

146 Growth performance and carcass quality of pigs housed in hoop barns fed diets containing alternative grains. L. J. Johnston^{*} and R. Morrison, *University of Minnesota*.

Dietary manipulation may be a useful tool for controlling increased carcass fat often observed in pigs raised in hoop barns (H). Our objective was to determine if a diet based on alternative grains (AG; barley, oats, buckwheat, field peas, and expeller soybean meal) would decrease carcass fatness and support growth performance of pigs housed in H similar to pigs fed diets based on corn and soybean meal (CS) housed in an environmentally-controlled confinement barn (C). To achieve this objective, pigs ($33.6 \pm .08$ kg) were housed in pens in H (6.1 m x 24.4 m; 80 mixed sex pigs/pen) or C (2.3 m x 4.6 m; 15 mixed sex pigs/pen). Pigs housed in H were fed CS or isolysin diets containing AG in a three-phase feeding program. Pigs housed in C only received CS diets. Housing and dietary treatments were replicated over winter and summer seasons for a total of 4, 4, and 14 pens/treatment for HCS, HAG, and CCS treatments, respectively. Pigs were marketed individually when they reached 113 kg BW. No season by treatment interactions were observed for any response criteria. Average daily gain (.88, .79, .87 kg; MSE = .0005) and feed/gain (3.16, 3.51, 2.97; MSE = .026) to the date when the first pigs were marketed for HCS, HAG, and CCS, respectively, were depressed ($P < 0.03$) by HAG compared with HCS while ADFI (2.77, 2.78, 2.58 kg; MSE = .016) was greater ($P < 0.05$) for HCS compared with CCS pigs. Last rib fat depth (2.60, 2.35, 2.35 cm; MSE = .012) was greatest ($P < 0.05$) for HCS pigs, while percentage carcass lean (54.42, 55.16, 55.48; MSE = .63) tended to be less ($P < 0.07$) in HCS vs CCS pigs. A trained sensory taste panel detected no differences in tenderness, juiciness, or overall desirability of pork loins ($n = 20$ /treatment) harvested from pigs during the winter season. Inclusion of alternative grains in diets for pigs housed in hoop barns depressed growth performance and elicited minor improvements in carcass quality. Eating quality of pork was not influenced by housing system or inclusion of alternative grains in the diet. Pork Checkoff funds provided financial support for this project.

Key Words: Hoop Barn, Carcass Traits, Swine

147 Effect of space allowance in rearing on feet and leg score and age at puberty of replacement gilts. M. G. Young^{*1}, M. D. Tokach¹, F. X. Aherne², S. S. Dritz¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Alberta Pig Company, Canada.

A total of 1,257 gilts (initially 38 kg) were used to determine the effect of space allowance during rearing on feet and leg score and age at puberty. Gilts were housed on totally-slatted floors and given a space

allowance of 1.1 or 0.8 m² in rearing. Gilts were weighed at entry and backfat depth, loin area and weight were recorded at approximately 200 d of age. From approximately 140 d of age, gilts were exposed to a vasectomized boar once per d to record age at puberty. At approximately 200 d of age, gilts were scored for feet and leg structure, movement, and toe evenness. For structure and movement, both the front and rear legs were scored separately on a scale of 1 to 5 by a trained specialist using NSIF guidelines. Toe evenness was scored on a scale of 1 to 3, with 1 equal to one very small and one normal toe or two small toes and 3 representing two even toes. Both the percentage of gilts with cracks on their hooves and the number of cracks per hoof were recorded. Space allowance in rearing had no effect ($P > 0.28$) on ADG (772 vs 761 g/d) from 80 to 200 d of age, backfat depth (18.5 vs 18.0 mm) or loin eye area at 200 d of age. A greater ($P < 0.05$) percentage of gilts attained puberty at the higher space allowance, but there was no difference in age at puberty for the gilts that attained puberty before leaving the rearing site. Front, rear, and overall structure, movement, and toe evenness scores were not different ($P > 0.22$) between the two space allowances. Gilts given greater space allowance in rearing had a greater ($P < 0.05$) percentage of cracks on their rear hooves and tended ($P < 0.10$) to have a greater total percentage of cracks compared to those given the lower space allowance. There was no difference in the number of cracks per hoof. Space allowance in rearing had no effect on feet and leg score for structure, movement, or toe evenness, but a higher percentage of gilts attained puberty by 200 d of age when given the greater space allowance.

Key Words: Gilts, Space Allowance, Puberty

148 Effects of lactation feeding strategy on gilt and litter performance. B. A. Peterson^{*1}, M. Ellis¹, B. F. Wolter², and N. Williams³, ¹University of Illinois, ²Maschhoff Pork, Inc., ³PIC USA.

Two experiments were conducted to evaluate the effects of lactation feeding strategy on sow feed intake and piglet performance. Exp. 1 was conducted as a randomized complete block design and utilized 90 PIC C23 gilts allotted to one of three treatments: 1) Fixed amount fed four times daily according to an increasing scale, 2) Feeding to appetite four times daily, and 3) Increasing restricted feeding scale for the first 10 days of lactation followed by to appetite feeding. Gilts were weighed and backfat depth was measured (P2 location) upon entry to the farrowing house and at weaning. Cross-fostering was performed to equalize litter size and weight across treatments. Birth, 10d, and weaning weights were recorded. Daily feed additions and refusals were recorded. No significant treatment differences in sow body weight, backfat measures, or litter performance measures were observed. Gilts on Trt. 3 had lower ($P < 0.05$) ADFI on days 1 through 7 ($3.2, 2.8,$ and 2.1 ± 0.19 kg for Trt. 1, 2, and 3, respectively), but ADFI was similar ($P > 0.05$) on all other days, and for the overall lactation period ($3.9, 3.7,$ and 3.5 ± 0.13 kg for Trt. 1, 2, and 3, respectively). Exp. 2 was conducted as a randomized complete block design and utilized 96 PIC C23 gilts allotted to one of two treatments. The treatments were 1) Hand fed to appetite and 2) Ad libitum access to feed via a self-feeder. The same methodology was used in Exp. 2 as in Exp. 1. Gilts on self feeders had higher ($P < 0.05$) ADFI (4.4 vs. 4.1 ± 0.11 kg) and lost significantly less ($P < 0.05$) backfat (1.8 vs. 3.1 ± 0.43 mm) than hand fed gilts. All other performance measures were similar ($P > 0.05$) for feeding strategy. This study suggests that the self-feeder used was effective at increasing feed intake and reducing backfat loss in sows during lactation.

Key Words: Backfat, Feed Intake, Sows

149 Comparison of agar plate and real-time PCR on enumeration of *Lactobacillus* and total anaerobic bacteria in dog feces. C. J. Fu^{*1}, J. N. Carter², J. H. Porter¹, and M. S. Kerley¹, ¹University of Missouri-Columbia, ²Nestle Purina PetCare PTC.

Thirty-two fecal specimens from Labrador Retriever dogs were used to compare agar plate and real-time PCR methods on enumeration of *Lactobacillus* (LACT) and total anaerobic bacteria (TOTA). Total anaerobic bacteria and LACT were counted (as cfu/g feces) by incubating 48 h at 37 C in an anaerobic gas chamber on species-selective media. Total genomic DNA from feces were extracted by the QIAamp DNA stool mini kit. The specific PCR primer sets for detecting LACT and the universal PCR primer sets for detecting TOTA were CGATGAGTGCTAG-GTGTGGA (forward); CAAGATGTCAAGACCTGGTAAG (reverse)

and CAGGCCTAACACATGCAAGTC (forward), GGGCGGTGTGTA-CAAGGC (reverse), respectively. The quantification of DNA (as DNA copy/g feces) by real-time PCR was performed with a LightCycler system with the QuantiTect™ SYBR green PCR kit for PCR amplification. The results indicated that there was a significant ($R^2 = 0.78$, $P < 0.01$; $R^2 = 0.21$, $P < 0.05$) correlation between cfu and DNA copy of LACT and TOTA. The regression equation for LACT and TOTA were $\text{Log (DNA copy)} = 0.83 \times \text{Log (cfu)} + 1.43$ and $\text{Log (DNA copy)} = 1.62 \times \text{Log (cfu)} - 6.32$. We conclude that the real-time PCR method could be used to enumerate LACT and TOTA in dog feces within 2 days instead of the 5 to 6 days required by plating.

Key Words: Bacteria, Plate Counting, Real-Time PCR

150 Influence of cereal grains on nutrient digestibility and fermentation end-products in the feces of horses consuming alfalfa cubes. L. A. Vogedes* and H. S. Hussein, *University of Nevada-Reno.*

Twenty geldings (five groups; similar age and BW) were used in a completely randomized design experiment to determine effects of grain supplementation of an alfalfa-cube diet on nutrient digestibility and hindgut fermentation. The geldings were housed individually, fed their diets in two equal meals (0600 and 1800), and adapted to five treatments over 6 wk. The treatments were alfalfa cubes (1% of BW) without (a control) or with one of four rolled cereal grains (i.e., barley, corn, naked oats, or oats) to provide a target level of 0.4% of BW as total nonstructural carbohydrates (TNC). Due to acute laminitis, three geldings (one in the control group and two in the barley group) were excluded and the TNC level was decreased to 0.2% of BW to ensure health throughout the adaptation (7 d) and sample collection (5 d) periods. Apparent digestibilities of DM, OM, CP, NDF, ADF, and cellulose were not affected ($P > 0.05$) by grain supplementation and averaged 63.2, 63.1, 79.5, 42.7, 39.9, and 50.3%, respectively. Regardless of the source, grain supplementation increased ($P < 0.05$) apparent digestibility of TNC (from 85.6 to 94.6%) and decreased ($P < 0.05$) fecal pH (from 7.04 to 6.74). Fecal concentrations of total VFA (mg/g DM) were highest for the barley and naked oats diets (averaging 11.73), intermediate for the oats diet (8.00), and lowest for the control and corn diets (averaging 5.00; $P < 0.05$). Fecal concentrations of lactate ($\mu\text{g/g DM}$) were highest for the barley diet (254), intermediate for the oats diet (138), and lowest for the remaining diets (averaging 100; $P < 0.05$). Fecal concentrations of $\text{NH}_3\text{-N}$ (mg/g DM) were highest for the naked oats diet (1.68), intermediate for the barley and oats diets (averaging 0.86), and lowest for the remaining diets (averaging 0.58; $P < 0.05$). Results suggested that horses consuming alfalfa cubes could be supplemented with rolled barley, corn, naked oats, or oats at levels not exceeding 0.2% of BW without negatively affecting nutrient digestion or overall health.

Key Words: Cereal Grains, Fermentation, Horses

151 Influence of forage species on digestion of nutrients and fecal concentration of fermentation end-products by grazing horses. L. A. Vogedes*¹ and H. S. Hussein¹, ¹*University of Nevada-Reno*, ²*University of Nevada-Reno.*

The objective was to determine effects of forage species on nutrient digestibility and fecal concentration of fermentation end-products by grazing geldings. Nine mature geldings were randomly allotted to three treatment groups of three each. One gelding was excluded during the adaptation period due to severe grease heel. Each group was assigned at random to one of three pastures containing tall fescue (*Festuca arundinacea*), orchardgrass (*Dactylis glomerata*), or ryegrass (*Lolium perenne*) at the vegetative stage. In a crossover design, the geldings grazed their pastures in three experimental periods (14 d each; 7 d for adaptation and 7 d for forage and total fecal collection) with ad libitum access to water and trace-mineralized salt. Intake and digestibility of DM were estimated by using ADL as an internal marker. Concentrations of CP, NDF, hemicellulose, and ether extract were not different ($P > 0.05$) among forages (averaging 11.1, 61.2, 20.4, and 0.3% on DM basis, respectively). The ADL content (DM basis) was lower ($P < 0.05$) for orchardgrass (9.0%) than for the other forages (averaging 11.3%). Except for ADF and cellulose, no differences ($P > 0.05$) in nutrient intakes were detected. Compared with orchardgrass and tall fescue, ryegrass had the highest ($P < 0.05$) intakes of ADF and cellulose. Daily DMI did not differ ($P > 0.05$) among forage species and averaged 2.2% of

BW. Digestibilities of DM, OM, CP, and NDF were higher ($P < 0.05$) for orchardgrass (i.e., 58.4, 62.5, 71.0, and 51.6%, respectively) than for the other forages which had similar ($P > 0.05$) digestibilities (averaging 49.4, 53.4, 62.9, and 43.7%, respectively). Digestibilities of cellulose and ADF were different ($P < 0.05$) among forage species with orchardgrass being highest and tall fescue being lowest. Fecal pH (6.8) and concentrations (mg/g fecal DM) of total VFA (18.99), individual VFA, or $\text{NH}_3\text{-N}$ (1.02) were not affected ($P > 0.05$) by forage species. The geldings were able to utilize orchardgrass more efficiently than tall fescue or ryegrass which appeared to be utilized at the same efficiency.

Key Words: Grasses, Digestion, Horses

152 In vitro fermentation characteristics of three forage species by fecal bacteria from horses. H. S. Hussein and L. A. Vogedes*, *University of Nevada-Reno.*

The objective was to determine in vitro fermentation characteristics of three grasses that were harvested at different times. The grasses (i.e., tall fescue [*Festuca arundinacea*], orchardgrass [*Dactylis glomerata*], and ryegrass [*Lolium perenne*]) were harvested first at the vegetative stage (Day 0) and then every two weeks (i.e., Day 14 and Day 28). They had similar ($P > 0.05$) concentrations (DM basis) of CP (11.1%) and NDF (61.2%). In a completely randomized design experiment, treatments were arranged as a 3 (forage species) \times 3 (harvest times) \times 4 (incubation times [6, 12, 24, and 48 h]) factorial. A total of 480 centrifuge tubes (50 mL each) containing 30 mL of anaerobic medium were used. The tubes (without [blanks] or with 0.5 g substrate DM) were incubated (38°C) with fecal inocula from each of three geldings consuming forage. No interactions ($P > 0.05$) were detected for any of the measurements evaluated. Ryegrass had lower ($P < 0.05$) in vitro digestibilities of DM (27.5 vs 31.0%) and OM (24.7 vs 27.9%) than tall fescue or orchardgrass which were similar ($P > 0.05$). Concentrations of total VFA, acetate, propionate, butyrate, isobutyrate, valerate, and isovalerate were not affected ($P > 0.05$) by forage species and averaged 12.19, 8.73, 2.29, 0.41, 0.29, 0.15, and 0.34 mM, respectively. Advancing maturity (i.e., Day 0 [vegetative], Day 14, and Day 28) decreased ($P < 0.05$) in vitro digestibilities of DM (31.2, 29.7, and 28.5%, respectively) and OM (27.9, 26.5, and 25.9%, respectively) but did not alter ($P > 0.05$) concentrations of total or individual VFA. There was an increase ($P < 0.05$) in digestibilities of DM and OM between 24 and 48 h of incubation without any change ($P > 0.05$) in concentrations of total or individual VFA. This suggested a shift in fermentation and production of gas (not measured) instead of VFA during the last 24 h of incubation. The results suggested ryegrass is less fermentable in the horses colon than tall fescue or orchardgrass.

Key Words: In Vitro, Horses, Fermentation

153 Colicin E1 kills *Escherichia coli* F4 (K88) and F18 strains in vitro. C. H. Stahl¹, L. M. Lincoln*¹, T. R. Callaway², and S. M. Lonergan¹, ¹*Iowa State University*, ²*USDA-ARS.*

Escherichia coli infections, causing post-weaning diarrhea or edema disease, are one of the most commonly reported disease problems in young pigs in this country, and cause substantial losses to the swine industry due to both mortality and morbidity. The *E. coli* strains considered primarily responsible for these diseases in pigs are F4 (K88) and F18. With worldwide concern over the use of prophylactic antibiotics in animal agriculture, the development of new products to protect swine from *E. coli* infections is urgently needed. Colicins are a class of antimicrobial peptides produced by and effective against *E. coli* and closely related species. In this study we examined the efficacy of one of these colicins (ColE1) against *E. coli* F4 and F18 strains in vitro. Colicin E1 production was induced with Mitomycin C addition to cultures of *E. coli* K12 containing the plasmid pColE1-K53(NCTC, London, England). The protein was purified from the supernatant of these cultures by ultrafiltration through a 30 kDa cut-off membrane followed by ion exchange chromatography (TMAE). The purified protein was then desalted with 10mM Tris, pH 7.4 in an ultrafiltration stir-cell. Cultures of *E. coli* F4 and F18 were grown in TSB overnight at 37degC, and aliquoted into fresh TSB, in duplicate, to provide an initial $\text{OD}_{600} = 0.1$. These cultures contained 0, 0.1, 1, 2.5, 5, 10, or 20 μg of the purified ColE1/mL, and were incubated at 37degC with shaking. The OD_{600} of these cultures was determined hourly for 8h. The growth rates of both strains were reduced within the first hour of incubation with ColE1.

Colicin E1 reduced the growth rate approximately 90% for *E. coli* F18, and 70% for *E. coli* F4, at a dose of 5 µg/mL. This protein holds promise as an alternative to the use of conventional antibiotics in feed for the treatment/prevention of *E. coli* disease in pigs.

Key Words: Antibiotic Alternative, Escherichia Coli, Swine

154 Estimation of the true ileal digestible (TID) lysine and sulfur amino acid requirement for nursery pigs weighing 12 to 24 kilograms. A. M. Gaines^{*1}, G. F. Yi², B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, C. D. Knight², and J. L. Usry³, ¹University of Missouri, ²Novus International Inc., ³Ajinomoto Heartland LLC.

The objective of this research was to estimate both the sulfur amino acid (SAA) and lysine requirement of 12 to 24 kg pigs in an attempt to define the "true" SAA:lysine ratio. In order to estimate the "true" SAA:lysine ratio, two concurrent 21 d experiments were conducted in the same commercial research facility. In Exp. 1, a total of 662 pigs (TR-4 × C22; 12.2 ± 0.18 kg) were allotted to one of five dietary treatments in a randomized complete block design (RCBD) with six replicate pens per treatment. Dietary treatments included five levels of TID lysine that corresponded to concentrations of 1.10, 1.20, 1.30, 1.40, and 1.50%, respectively. Diets contained the same inclusion of soybean meal and dietary lysine content was increased by adding L-lysine HCl. In Exp. 2, a total of 665 pigs (TR-4 × C22; 12.3 ± 0.18 kg) were allotted to one of five dietary treatments in a RCBD with six replicate pens per treatment. Dietary treatments included five levels of TID SAA that corresponded to concentrations of 0.63, 0.70, 0.77, 0.83, and 0.90%, respectively. Diets were formulated at a 1.40% TID lysine and dietary SAA content was increased by adding Alimet[®] feed supplement. For Exp. 1, increasing dietary lysine increased (linear, P = 0.06; quadratic, P = 0.06) ADG (549, 568, 586, 577, and 572 g/d) and improved (linear, P < 0.01) G/F (0.645, 0.650, 0.659, 0.675, and 0.672). For Exp. 2, increasing dietary SAA increased (quadratic, P < 0.05) ADG (558, 590, 586, 568, and 577 g/d) and improved (linear, P < 0.001; quadratic, P = 0.05) G/F (0.630, 0.656, 0.672, 0.681, and 0.683). Using segmented regression procedures, the lysine requirement was estimated to be 1.27%, and the SAA requirement was estimated to be 0.72 and 0.84% for ADG and G/F, respectively. The calculated "true" TID SAA: lysine ratio was estimated to be 56.7 and 66.1% for ADG and G/F, respectively.

Key Words: Lysine, Sulfur Amino Acids, Pigs

155 Evaluation of the true ileal digestible (TID) lysine requirement for early finishing gilts. P. Srichana^{*1}, A. M. Gaines¹, B. W. Ratliff¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, ²Ajinomoto Heartland LLC.

Two experiments were conducted at a commercial research site in order to evaluate the true ileal digestible (TID) lysine requirement for 30 to 44 kg and 44 to 67 kg gilts. In Exp. 1, a total of 945 gilts (TR-4 × C22; 29.9 ± 0.11 kg) were used to evaluate the TID lysine requirement from 30 to 44 kg BW. Pigs were assigned to one of five dietary treatments in a completely randomized design with 9 replicate pens/treatment and 21 pigs/pen. Dietary treatments included five concentrations of TID lysine (0.80, 0.90, 1.00, 1.10 and 1.20%). In Exp. 2, a separate group of 840 gilts (TR-4 × C22; 44.4 ± 0.20 kg) were used to evaluate the TID lysine requirement from 44 to 67 kg BW. Pigs were assigned to one of five dietary treatments in a completely randomized design with 8 replicate pens/treatment and 21 pigs/pen. Dietary treatments include five concentrations of TID lysine (0.75, 0.85, 0.95, 1.05 and 1.15%). In both experiments, corn-soybean meal based diets were used and contained 0.15% L-lysine HCl. Dietary lysine was increased by adding soybean meal. For Exp. 1, increasing dietary lysine increased (linear, P = 0.02; quadratic, P = 0.001) ADG (875, 934, 966, 930, and 934 g/d) and improved (linear, P < 0.001; quadratic, P = 0.001) gain/feed (0.498, 0.526, 0.550, 0.548, and 0.544). Furthermore, increasing dietary lysine resulted in a linear decrease (P = 0.01) in ADFI (1755, 1783, 1760, 1696, and 1715 g/d). For Exp. 2, increasing dietary lysine increased (quadratic, P = 0.12) ADG (1048, 1075, 1089, 1070, and 1070 g/d) and improved (linear, P = 0.001; quadratic, P < 0.10) gain/feed (0.448, 0.462, 0.467, 0.469, and 0.471). Increasing dietary lysine also resulted in a linear decrease (P = 0.10) in ADFI (2336, 2332, 2332, 2286, and 2268 g/d).

These data indicate that the TID lysine requirement of 30 to 44 kg and 44 to 67 kg gilts are 1.00% and 0.95%, respectively.

Key Words: Lysine, Pigs, Growth

156 Determination of the true ileal digestible isoleucine requirement for 90 kg barrows. D. C. Kendall^{*1}, B. J. Kerr², R. W. Fent¹, S. X. Fu¹, J. L. Usry³, and G. L. Allee¹, ¹University of Missouri, ²USDA-ARS-MWA-SOMMRU, ³Ajinomoto Heartland LLC.

A 21-d experiment was conducted to determine the true ileal digestible (TID) isoleucine requirement for 91 to 116 kg barrows (n=170, PIC C-23). Pigs were allotted by weight in a randomized complete block design and fed one of five dietary treatments with five replicates of six or seven pigs per pen. A four-point titration curve was constructed with a basal diet containing corn and 5.0% blood cells. The basal diet contained 0.25% TID Ile, 0.63% TID lys, and 3.47 Mcal ME/kg. The 0.63% TID lys was considered above the requirement for this genotype. Additional amino acids were supplied from crystalline sources to meet minimum amino acid ratios. L-Ile was added at the expense of cornstarch, creating the three other TID Ile levels (0.30, 0.35, and 0.40% TID Ile). A control corn-soybean meal diet was formulated to contain 0.63% TID lys, 3.47 Mcal ME/kg, and 0.47% TID Ile. There were linear improvements (P < .001) and quadratic trends in final BW (P < .07) and ADG (0.662, 0.918, 1.15, and 1.21 kg/day, respectively; P < .06). A linear increase in ADFI (2.62, 3.01, 3.55, and 3.62 kg/day, respectively; P < 0.001) was observed with increasing TID Ile, resulting in a quadratic improvement in G:F with increasing TID Ile (0.251, 0.303, 0.324, 0.335, respectively; P < .01). Pigs fed the control diet had similar ADG (1.19 vs. 1.21) and G:F (0.335 vs. 0.335) compared to pigs fed the 0.40% TID Ile diet. One-slope breakpoint analysis of ADG and G:F yielded TID Ile requirement estimates of 0.361 and 0.357, respectively. This experiment demonstrates that the TID Ile requirement for 91 to 117 kg barrows is near 0.36% TID Ile. It also illustrates that pig performance is comparable when diets are formulated with blood cells, provided additional Ile is supplied.

Key Words: Pigs, Isoleucine, Growth

157 Evaluation of the true ileal digestible valine:lysine ratio for 13 to 32 kg barrows. D. C. Kendall^{*1}, B. J. Kerr², J. W. Frank¹, R. W. Fent¹, J. L. Usry³, and G. L. Allee¹, ¹University of Missouri, ²USDA-ARS-MWA-SOMMRU, ³Ajinomoto Heartland LLC.

Two experiments were conducted to determine the true ileal digestible (TID) valine:lysine (Val:Lys) ratio for 13 to 32 kg barrows. In Exp. 1, 54 individually housed barrows (PIC C-23; BW = 21.4 kg) were allotted in a randomized complete block design (RCB) with 9 replicate pens in a five-point Val:Lys titration for 14 d. In Exp. 2, 147 barrows (PIC C-23; BW = 13.5 kg) were allotted in a RCB with 7 replicate pens of 3 pigs/pen in a six-point Val:Lys titration for 21 d. Both experiments utilized a corn-soybean meal basal diet containing 0.60% L-Lysine-HCl and additional crystalline amino acids supplied as necessary to meet minimum amino acid ratios, excluding valine. The basal diet was formulated to 1.10% TID lys, 3.37 Mcal ME/kg, and a Val:Lys ratio of 55. L-Valine was added to the basal diet to achieve ratios of 60, 65, 70, and 75 in Exp. 1 and 60, 65, 70, 75, and 80 in Exp. 2. In each experiment, a control corn-soybean meal diet was formulated to contain 1.10% TID lys, 3.37 Mcal ME/kg, 0.20% L-Lysine-HCl, and a Val:Lys ratio of 74. In Exp. 2, serum samples were collected from two pigs/pen at d 0 and d 21 for determination of serum urea nitrogen (SUN). In Exp. 1, a linear increase in ADG (713, 750, 800, 796, and 785 g/d, respectively; P < 0.05) and G:F (545, 549, 572, 584, and 562 g/kg, respectively; P < 0.07) was observed with increasing Val:Lys. Breakpoint analysis revealed TID Val:Lys estimates of 65.8 and 66.2 for ADG and G:F, respectively. In Exp. 2, there was a trend for quadratic improvements in ADG (P < 0.08) and G:F (550, 557, 583, 573, 585, 572 g/kg, respectively; P < .07) with increasing Val:Lys, characterized by an improvement to a ratio of 65 and a plateau thereafter. Pigs fed the control diet did not differ from those fed 65 TID Val:Lys in Exp. 1, but did have improved G:F ratio in Exp. 2 (613 vs. 583 g/kg; P < .03). SUN levels were unaffected by dietary treatment. Using combined requirement estimates, the data suggest that a TID valine:lysine ratio of 65 appears adequate in maintaining performance for pigs from 13 to 32 kg.

Key Words: Pigs, Valine, Growth

158 A comparison of ideal amino acid ratios based on total amino acid content versus true ileal digestible amino acid content and the effects on growing pig performance. A. L. Yager*, L. M. Wilson, K. L. Saddoris, L. Peddireddi, B. T. Richert, R. B. Hinson, and J. S. Radcliffe, *Purdue University*.

Two hundred ten gilts (Dekalb 45 x EB) were used in a 6-wk grower experiment to study the effects of dietary amino acid level and formulation method on growth performance. Pigs were blocked by BW and randomly assigned to a 2x3 factorial arrangement of treatments with diets formulated on a total or true ileal digestible (TID) basis to one of three Lys levels (100, 110, or 120% of NRC, 1998). Total or TID levels of TSAA, Thr, Trp, and Val were maintained at a constant ratio relative to Lys for all diets based on NRC recommendations. Dietary treatments were fed throughout the trial in two phases (Phase 1, d 1-21; Phase 2, d 21-42). Pigs were housed in 30 pens (7 pigs/pen) with 5 pens per treatment. Pig BW and pen feed intake were recorded weekly. Ultrasonic estimates of 10th and last rib backfat thickness were determined on 4 pigs/pen at the beginning and end of the trial. Average initial and final BW were 30.9 and 67.3 kg, respectively. No interactions (P>.10) were observed between formulation method and amino acid level. ADG linearly increased during Phase 1 (P<0.001) and overall (P<0.001), but not during Phase 2, as dietary Lys level increased. Overall, ADG was 0.822, 0.873, and 0.900 kg/d for pigs fed diets containing 100, 110, and 120% of NRC Lys, respectively. ADFI linearly increased (P<0.05) during Phase 1 and overall, and tended to increase (P<0.10) during Phase 2 as the level of Lys was increased. Lys level had no effect (P>0.10) on G:F or backfat thickness. Formulation method did not affect (P>0.10) ADG, G:F, or backfat thickness. Pigs fed diets formulated on a total basis during Phase 1, consumed 102 g/d more feed than pigs fed diets formulated on a TID basis (P<.02). When diets are corn-SBM based, diet formulation method (total or TID) had minimal effects on grower pig performance. However, the most recent NRC standards for grower pig Lys and amino acid requirements may underestimate the requirements by up to 20%.

Key Words: Pig, Amino Acids, Growth

159 Effects of lysine source on growth performance of 27 to 114 kg barrows.. D. C. Kendall*¹, G. L. Allee¹, G. Gourley², and J. L. Usry³, ¹University of Missouri, ²Swine Graphics Enterprises, ³Ajinomoto Heartland LLC.

An experiment was conducted to evaluate L-Lys HCl inclusion in finishing barrow diets from 27 to 114 kg under commercial conditions. The experiment consisted of four dietary phases: Phase 1 (27 to 46 kg), Phase 2 (46 to 65 kg), Phase 3 (65 to 90 kg), and Phase 4 (90 to 114 kg). Barrows (n= 1040; PIC 1055 x 337) were initially allotted in a randomized complete block design with 8 replicate pens of 26 pigs. The five dietary treatments consisted of increasing L-Lys HCl inclusion with pigs remaining on their original treatment schemes throughout the experiment. In Phase 1, diets contained 0.0, 0.0875, 0.175, 0.2625, and 0.35% L-Lys HCl, respectively, with only supplemental methionine and threonine supplied to meet minimum amino acid ratios. Maximal levels of dietary L-Lys HCl addition were progressively decreased in each dietary phase. In Phase 4, diets contained 0.0, 0.056, 0.1125, 0.1685, and 0.225% L-Lys HCl, respectively, with only supplemental methionine and threonine supplied. Diets were formulated at 1.15, 0.94, 0.70, and 0.60% TID lys for each phase and were isocaloric. There were no differences in pig performance between any dietary treatments during the experiment, except for a quadratic effect for G:F with increasing lysine level in Phase 4 (.314, .308, .305, .311, and .313 g/g; P<.03). Overall ADG (893, 899, 886, 877 and 884 g/d; P>.20), ADFI (2.33, 2.34, 2.34, 2.29 and 2.33 kg/d; P>.25), and G:F (.384, .385, .379, .379 and .381 g/g; P>.72) was unaffected by dietary treatment. This experiment demonstrates that high levels of crystalline amino acids can replace soybean meal in commercial finishing diets, provided minimum amino acid ratios are maintained.

Key Words: Pigs, Amino Acids, Growth

160 Evaluation of high synthetic lysine diets for late nursery and early finishing pigs. A. M. Gaines*¹, B. W. Ratliff¹, D. C. Kendall¹, P. Srichana¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, ²Ajinomoto Heartland LLC.

Two experiments were conducted at a commercial research site in order to evaluate the effects of high synthetic lysine inclusion on growth performance of late nursery and early finishing pigs. In Exp. 1, a total of 880 pigs (TR-4 x C22; 14.8 ± 0.15 kg) were used in a completely randomized design with 4 replicate feeders/treatment and 44 pigs/feeder. Pigs were allotted to one of five dietary treatments containing 0.20, 0.35, 0.50, 0.65, and 0.80% added L-lysine HCl, respectively. Diets were formulated at a 1.21% true ileal digestible (TID) lysine and additional synthetic amino acids were supplied as necessary to meet minimum amino acid ratios. Growth performance data were collected for 14 d. For Exp. 1, increasing L-lysine HCl inclusion decreased (linear, P < 0.001; quadratic, P < 0.01) ADG (653, 644, 658, 617, and 572 g/d) and decreased (linear, P < 0.001; quadratic, P = 0.05) G/F (0.649, 0.633, 0.643, 0.609, and 0.577). In Exp. 2, a total of 839 pigs (TR-4 x C22; 57.1 ± 0.13 kg) were used in a completely randomized design with 8 replicate pens/treatment and 20-21 pigs/pen. Pigs were allotted to one of five dietary treatments containing 0.00, 0.10, 0.20, 0.30, and 0.40% added L-lysine HCl, respectively. Diets were formulated at a 0.93% TID lysine and additional synthetic amino acids were supplied as necessary to meet minimum amino acid ratios. Growth performance data were collected for 21 d. For Exp. 2, there were no differences in ADG (P > 0.36) with increasing L-lysine HCl inclusion (875, 857, 880, 862 and 866 g/d). There were also no differences in G/F (P > 0.21) with increasing L-lysine (0.394, 0.391, 0.390, 0.388, and 0.387). Results from these two experiments indicate that if minimum amino acid ratios are maintained, up to 0.50% L-lysine HCl can be added in late nursery pig diets and 0.40% L-lysine HCl in early finishing diets without compromising growth performance.

Key Words: Lysine, Pigs, Growth

161 Evaluation of high synthetic lysine diets for pigs fed ractopamine HCl (Paylean®). A. M. Gaines*¹, B. W. Ratliff¹, P. Srichana¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, ²Ajinomoto Heartland LLC.

The objective of this 21 d experiment was to evaluate the effects of high synthetic lysine inclusion on growth performance and carcass characteristics of pigs fed ractopamine HCl (Paylean®). A total of 1,134 pigs (TR-4 x C22; 98.0 ± 0.24 kg) were allotted to one of three dietary treatments in a completely randomized design with 18 replicate pens/treatment (21 pigs/pen). Dietary treatments included a high-crude protein control diet (18.2% crude protein) with 0.10% added L-lysine HCl (HCP), a low-crude protein diet (16.0% crude protein) with 0.30% added L-lysine HCl with no supplemental L-threonine or DL-methionine (LCP), and a low-crude protein diet with 0.30% added L-lysine HCl with supplemental L-threonine and DL-methionine (LCPAA). Supplementation of the LCPAA diet with L-threonine and DL-methionine increased the true ileal digestible (TID) threonine:lysine ratio from 53.6 to 69.6% and the sulfur amino acid:lysine ratio from 52.4 to 58.2%. All diets were corn-soybean meal-based with 2% choice white grease formulated at a 0.93% TID lysine and contained 7 ppm Paylean®. During the 21 d experiment, there was a trend for pigs fed either the HCP or LCPAA diet to have increased ADG (P = 0.11) as compared to pigs fed the LCP diet (1070, 1070, and 1034 g/d, respectively). The pigs fed either the HCP or LCPAA diet also had a higher G/F (P < 0.01) as compared to pigs fed the LCP diet (0.371, 0.366, and 0.352, respectively). There were no differences in ADFI (P > 0.57). For carcass characteristics, there were no differences in yield (P = 0.41), backfat (P = 0.21), loin depth (P = 0.56), or calculated percent lean (P = 0.33). These data indicate that up to 0.30% L-lysine HCl can be added in Paylean® diets without compromising growth performance or carcass characteristics provided the diets are supplemented with L-threonine and a methionine source. In addition, considering the low-protein diets used in this experiment reduced dietary protein two percentage units one could also expect reductions in nitrogen excretion and ammonia emission.

Key Words: Ractopamine, Lysine, Pigs

162 Comparison of feeding grower-finisher pigs sequences of multiple diets declining in digestible lysine:digestible energy (DE) ratio. M. K. O'Connell^{1,2}, P. B. Lynch¹, and J. V. O'Doherty², ¹Teagasc, Moorepark, Ireland, ²University College Dublin, Ireland.

The objective of this study was to compare a single diet to sequences of five diets declining in digestible lysine:DE ratio based on performance, nitrogen excretion (NEXC) and nitrogen retention (NRET) of grower-finisher pigs. Single-sex groups (n=32) of 14 pigs (40 kg) were allotted to one of four treatments in an RCB design: single diet (SD), high lysine sequence (HL), medium lysine sequence (ML) or low lysine sequence (LL). A sequence involved five diets, each fed for two weeks. Digestible lysine:DE ratio was 0.70 g/MJ for SD, and declined in increments of 0.035 g/MJ for HL (from 0.77 to 0.63 g/MJ), ML (from 0.70 to 0.55 g/MJ) and LL (from 0.63 to 0.48 g/MJ). Diets were isoenergetic, based on barley, wheat, soybean meal and synthetic amino acids. Pigs were slaughtered at 95 kg. No differences (P>0.05) were observed between SD and HL or ML for ADG, feed intake or feed conversion ratio (FCR). LL pigs had lower ADG and poorer FCR than SD pigs (P<0.05). Carcass lean (LEAN) was similar across treatments (P>0.05). NEXC and NRET by HL and SD pigs were similar (P>0.05). ML and LL pigs had lower NEXC (P<0.05, P<0.001) and higher NRET than SD (P<0.001). Feeding the ML or LL sequences increased nitrogen retention and decreased nitrogen excretion compared to SD, but feeding the HL sequence did not. However, performance of pigs on the LL treatment was depressed.

	Treatment				SEM	P-values ¹		
	SD	HL	ML	LL		SD vs ML	SD vs LL	ML vs LL
ADG, g/d	852	840	860	817	10.7	ns		*
FCR, kg/kg	2.49	2.49	2.50	2.59	0.03	ns		*
LEAN, g/kg	595	594	591	590	2.0	ns	ns	
NEXC ²	3.13	3.15	2.81	2.46	0.07	*		***
NRET ³	0.24	0.25	0.27	0.28	0.003	***		***

¹ *P<0.05, ***P<0.001, ns P>0.05

² NEXC (kg/pig): (N intake) - (carcass N - N at start)

³ NRET: N gain as a proportion of intake

Key Words: Grower-Finisher Pigs, Digestible Lysine:DE

163 Dehydrated alfalfa meal reduces urinary urea excretion in finishing gilts. J. T. Yen*, USDA, ARS, U.S. Meat Animal Research Center.

Reducing urinary urea excretion decreases ammonia emission by pig operations. This study determined effects of dietary inclusion of 10% dehydrated alfalfa meal on urinary urea excretion, growth, and total manure output of finisher gilts. Two groups of four pairs of littermate gilts (83.6 ± 0.9 kg BW) were used. Gilts were housed individually and fed twice daily (0800 and 1500). Daily feed allowance was 2.6 × maintenance DE requirement. Feed was mixed with water (1 g per mL) at each feeding. Littermate gilts were assigned to a basal, typical corn-soybean meal finisher diet or a diet containing 10% dehydrated alfalfa meal. The diets were formulated to consist of same amounts of N, GE, Ca, total P, apparent ileal digestible lysine, threonine, tryptophan, and methionine. Gilts were weighed and their daily feed allowance recalculated weekly. On d 14 and again on d 18, each pig was given 2 g of ferric oxide. Total feces were collected between appearances of the first and second red feces. Gilts were fitted with indwelling Foley bladder catheters on d 14. A 96-h total urine collection was started at 1000 h on d 15. Gilts were weighed again upon completion of total fecal collection. Results for the basal and the 10% alfalfa meal treatments, respectively were: ADG, 686 and 785 g (P < 0.05); ADFI, 2,495 and 2,594 g (P < 0.05); gain/feed, 0.28 and 0.30 (P = 0.08); N intake, 56.4 and 55.6 g/d (P = 0.34); urine output, 6,606 and 5,795 mL/d (P = 0.46); urinary urea excretion, 37.3 and 29.1 g/d (P < 0.05); urine N excretion, 23.9 and 20.2 g/d (P < 0.05); wet feces output, 678 and 1,023 g/d (P < 0.01); dry feces weight, 233 and 332 g/d (P < 0.01); feces N excretion, 7.7 and 10.6 g/d (P < 0.01); and total manure output (urine + wet feces), 7,284 and 6,819 g/d (P = 0.68). This study demonstrates clearly that inclusion of 10% dehydrated alfalfa meal in a finisher diet can effectively reduce urine urea excretion and will not increase total manure output in gilts when compared with a typical, corn-soybean meal finisher diet.

Key Words: Alfalfa Meal, Finisher Pigs, Urine Urea

164 Effects of adding pantothenic acid into reduced protein diets on performance and carcass traits of grow-finish pigs. H. Yang^{*1}, J. Lopez², T. Radke¹, M. Cecava¹, D. Holzgraefe¹, and J. Less³, ¹ADM Alliance Nutrition, ²ADM Animal Health and Nutrition, ³ADM BioProducts Division.

The effect of pantothenic acid (PA) levels on growth and carcass traits of grow-finish pigs fed normal (N) or 3% reduced (R) dietary protein content (DP) diets was evaluated. Pigs (n = 216; 20.6 kg BW) were blocked by initial weight and gender to one of four treatments, with nine pens per treatment and six pigs per pen. Treatment arrangement was a 2 x 2 factorial, with two levels of PA (8 v 45 ppm) and two levels of DP (N v R). DP was reduced by replacing soybean meal with crystalline Lys (approximately 3 g Lys.HCl/kg feed), Met, Trp and Thr. Total Lys and ideal protein ratio were the same across treatments within phase. ADG, ADFI and G/F were measured on d 17, 38, 59, 80, 94 and at the ending targeted BW of 125 kg. Longissimus muscle area (LMA) and 10th rib fat depth (BF) were measured on d 59 and at the ending BW using an ultrasound longitudinal probe. Reduced DP improved ADG in 8 ppm PA diets, but decreased ADG in 45 ppm PA diets, yielding an interaction between PA and DP (P = 0.04 and P = 0.08 at d 59 and overall, respectively). Reduced DP improved G/F (P = 0.04) and decreased ADFI (P = 0.02, data not shown) during the overall study. DP had no significant effect on LMA and BF (P > 0.10). Increased PA tended to improve LMA on d 59 (P = 0.08). In summary, increased PA improved LMA in growing pigs, while a 3% reduced DP improved G/F with no influence on BF. No supporting additive effects were found between PA and DP.

	N		R		SE	P		
	N	R	N	R		DP	PA	Int
PA, ppm	8	8	45	45				
BW d 59, kg	74	77	78	76	0.9	0.53	0.33	0.02
BW market, kg	127	125	125	126	1.3	0.56	0.84	0.27
ADG d 0-59, g	921	944	955	927	11.6	0.84	0.47	0.04
ADG d 0-market, g	910	931	944	923	11.7	0.98	0.25	0.08
G/F d 0-60	0.465	0.474	0.469	0.473	0.004	0.13	0.78	0.55
G/F d 0-market	0.367	0.383	0.376	0.380	0.005	0.04	0.58	0.23
LMA d 59, cm ²	33.15	33.10	33.40	33.86	0.29	0.48	0.08	0.38
LMA market, cm ²	39.16	39.33	39.53	39.63	0.33	0.68	0.31	0.92
BF d 59, cm	0.96	0.97	0.94	0.99	0.03	0.43	0.99	0.49
BF market, cm	1.62	1.63	1.62	1.63	0.05	0.83	0.96	0.98

Key Words: Grow-Finish Pigs, Vitamin, Amino Acids

165 Effect of increasing dietary crude protein concentration on growth performance and serum insulin-like growth factor-I concentration in growing-finishing gilts. R. L. Fischer*, P. S. Miller, and S. J. Kitt, University of Nebraska.

This experiment was conducted to investigate the effects of increasing dietary protein intake on growth performance and serum insulin-like growth factor-I (IGF-I) concentration in growing-finishing gilts. Thirty-five crossbred gilts with an initial BW of 33.7 kg were used in a 28-d growth study. The gilts were randomly allocated to one of five dietary treatments and individually penned (7 replicates/treatment). The diets were standard corn soybean meal diets, which were formulated to contain 10, 14, 18, 22, or 26% crude protein by changing the ratio of corn to soybean meal in the diet. Pig and feeder weights were recorded weekly for the determination of ADG, ADFI, and feed efficiency (ADG/ADFI). Blood samples were collected weekly and analyzed for urea and IGF-I concentrations. There was no difference in ADFI (1.84, 1.99, 1.82, 1.89, 1.79 kg, respectively; P > 0.10) among the treatments throughout the 28-d experimental period. Dietary protein concentration had linear and quadratic effects on ADG (0.52, 0.85, 0.92, 0.97, 0.93 kg, respectively; P < 0.01) and ADG/ADFI (0.28, 0.42, 0.51, 0.52, and 0.52; P < 0.01). Fat-free lean gain was affected (linear and quadratic; P < 0.01) by dietary protein concentration (163, 320, 376, 386, and 373 g/d, respectively). Plasma urea and serum IGF-I concentrations were similar among the five dietary treatments on d 0; however, dietary protein concentration had linear and quadratic effects on urea (23.36, 21.75, 24.43, 34.57, and 46.49 mg/dL, respectively; P < 0.01) and IGF-I concentration (140, 482, 507, 477, and 446 ng/mL, respectively; P < 0.01) during Wk 4. The decrease in fat-free lean gain observed in gilts fed the 14% CP diet was not associated with a decrease in serum IGF-I concentration.

Key Words: Growth, Pigs, IGF-I

166 Impact of soybean contaminants on growth performance and pork quality. E. O. Castaneda^{*1,2}, M. Ellis¹, D. C. Mahan³, F. K. McKeith¹, and D. Brana^{1,4}, ¹University of Illinois, ²CONACYT-Mexico, ³The Ohio State University, ⁴INIFAP-Mexico.

The objective of the study was to compare the effects of dietary inclusion of various soybean contaminants (normally present in soybean meal), at various levels and combination on pig growth performance, carcass characteristics, and meat quality. The study was carried out as a completely randomized design with 7 dietary treatments with corn as the grain source: 1) control (soybean meal, no added contaminant), 2) gums (3% of the diet), 3) soapstock (1.5%), 4) weed seeds/trash (2%), 5) all contaminants (6.5%), 6) refined soybean oil (1.75, 1.20 and 0.80 % at each production phase, respectively), and 7) roasted whole soybeans. A total of 168 pigs were housed with 4 pigs/pen in single-sex pens. Diets were formulated to about 80% of the lysine requirement to cause dependence on the soybean amino acid source, to the same Lys:Energy ratio, and fed in three diet sequences for 84 d (Grower [35 to 55 kg BW, 21 d], Finisher I [56-95 kg BW, 42 d], and Finisher II [96-120 kg BW, 21d]). At the end of the study two pigs/pen were randomly selected for slaughter. For the overall period, there was no treatment effect ($P > 0.05$) on daily gain (1.01, 0.94, 0.96, 0.95, 0.97, 0.96, and 0.91 kg/d; SEM = 0.034; for treatments 1, 2, 3, 4, 5, 6, and 7, respectively), daily feed intake (2.58, 2.61, 2.57, 2.57, 2.44, 2.49, and 2.24 kg/d; SEM = 0.108), and gain:feed ratio (0.40, 0.36, 0.38, 0.37, 0.40, 0.39, and 0.41; SEM = 0.016). Compared to the control group, the hot carcass weight was lower ($P < 0.05$) for treatments 2 and 7 (92.3 vs. 84.2 and 81.4 kg). However, no differences were found ($P > 0.05$) for the 10th rib backfat thickness, longissimus muscle area, fat-free lean percentage, or for the meat quality measurements (pH, drip loss, subjective color, marbling and firmness, and Hunter L#42#, a#42#, and b#42# values). In conclusion, there was no effect of the soybean contaminants normally present in soybean meal when fed to growing-finishing pig on performance, carcass characteristics, or meat quality.

Key Words: Pig, Soy Contaminants, Meat Quality

167 Relative bioavailability of fermented soybean meal to spray dried plasma protein in nursery diets. S. W. Kim*, R. L. McPherson, and J. Fei, Texas Tech University.

A total of 175 pigs, weaned at d 21 of age, were used to determine the relative bioavailability (RBV) of fermented soybean meal (FS, Genebio Tech) as a protein source for young pigs in comparison to plasma protein (PP) using a classic slope-ratio design. Pigs were allotted to one of five dietary treatments representing basal group (BA, without PP and FS), 3.7% PP (PP1), 7.3% PP (PP2), 4.9% FS (FS1), and 9.8% FS (FS2). All experimental diets commonly contained 40% corn, and 20% SBM. Each diet had different combination of PP and corn starch or FS and corn starch. Corn starch to vegetable oil ratio was altered to match energy content among the treatment diets. Crystalline amino acids were added to FS treatment diets to match amino acid profiles to those of PP treatment diets. Each treatment had 5 replicates and 7 pigs per pen. Pigs were fed the experimental diets for 3 weeks and had free access to feed and water. Feed intake and body weight were measured weekly. Pigs fed the PP1, PP2, and FS2 diets had greater ($P < 0.05$) ADG than the BA pigs whereas feed intake was the same among the treatments. Gain/feed of the FS2 pigs was greater ($P < 0.05$) than those in other treatments. The BA pigs had the lowest ($P < 0.05$) gain/feed. Relative bioavailability (RBV) of FS to PP was 105.6% based on the changes of ADG of pigs as they received increased amount of lysine from the diets. The ADG was modeled as $Y = 204.07 + 32.81 \times PP + 34.65 \times FS$, where $Y = ADG$, PP and FS are lysine intake (g/d) above the basal diet, P value for the PP slope = 0.0010, P value for the FS slope = 0.0011, P value for the intercept = 0.0001, P value for the overall model = 0.0013, and P value for the difference between the slopes of PP and FS = 0.83. Thus, there was no difference between the slopes of PP and FS but the RBV of FS to PP was calculated based on $(34.65 / 32.81) \times 100 = 105.6\%$. Fermented soybean meal, when crystalline amino acids were added to match the amino acid profiles to those of spray dried plasma protein, can replace the use of spray dried plasma protein during the first 3 weeks after weaning.

Key Words: Pigs, Fermented Soybean Meal, Relative Bioavailability

168 Effect of different soy protein concentrate sources on growth performance of weanling pigs. N. A. Lenehan*, R. D. Goodband, M. D. Tokach, J. L. Nelssen, S. S. Dritz, J. M. DeRouche, C. N. Groesbeck, and K. R. Lawrence, Kansas State University.

Three experiments were conducted using 486 weanling pigs (216 in Exp. 1; 210 in Exp. 2; 60 in Exp. 3) to determine the effects of soy protein concentrate (SPC) source on performance of weanling pigs compared with a milk protein-based diet, or a diet containing 40% soybean meal (SBM). There were 6 pigs/pen with 9, 7, or 10 reps/treatment in Exp. 1, 2, and 3, respectively. Experimental diets were fed from d 0 to 14. A common diet was fed from d 14 to 28. In Exp.1, SBM was replaced on a lysine basis by 28.6% of each SPC source (Source 1-Soycomil P[®], ADM; Source 2-Profine E, Solae/Central Soya). Pigs fed the diet containing 40% SBM had similar ADG and ADFI as pigs fed the milk protein-based diet from d 0 to 14, and both were greater than pigs fed either SPC source. In Exp. 2, either all or half of the SBM was replaced by 28.6 or 14.3% SPC from Source 1 and 2. From d 0 to 14 and 0 to 28, there was SPC source by level interaction for ADG ($P < 0.01$) and ADFI ($P < 0.07$). Replacing SBM with SPC from Source 1 did not influence pig performance. However, replacing SBM with SPC from Source 2 resulted in a quadratic ($P < 0.05$) change in ADG with performance being improved for the diet containing 14.3% SPC, but no benefit to replacing all the SBM with SPC. Replacing SBM with SPC from either source improved gain:feed (G/F; quadratic, $P < 0.01$) with the best G/F for pigs fed the diets with 14.3% SPC. To test whether the poor ADG of pigs fed 28.6% SPC was a result of decreased palatability; Exp. 3 was a preference test to examine the feed intake response of pigs offered a choice of consuming the diets containing 40% SBM or 28.6% SPC from Source 2. Daily feed intake was 0.19 and 0.005 kg for the 40% SBM and 28.6% SPC diets, respectively ($P < 0.0001$). The poor intake of the SPC diet may indicate a palatability problem when high levels of SPC are included in the diet. Our results suggest replacing a portion, but not all, of the SBM in the diet with SPC from Source 2 improves pig performance.

Key Words: Weanling Pigs, Soy Protein Concentrate, Growth

169 Effects of lactic acid and lactose on growth performance of nursery pigs. M. F. Palacios, K. T. Soltwedel*, G. R. Hollis, and J. E. Pettigrew, University of Illinois.

The objective of this study was to measure the effects of lactic acid (ACID) and lactose (LAC), separately and combined, on growth performance of young pigs in a commercial nursery during a 6-wk growth assay. A total of 1584 pigs, sorted by sex into four separate rooms, were used in this study. Each room consisted of 12 pens of barrows or 12 pens of gilts. The study was conducted as a 2 x 2 factorial arranged in a randomized complete block design. Within each room, pigs were allotted visually by body weight to each of three blocks for a total of 12 blocks. A four-phase feeding program was employed for this study, with Phases 1, 2, 3, and 4 corresponding to Week 1, Week 2, Weeks 3 and 4, and Weeks 5 and 6 of the study, respectively. Experimental diets were fed during Phases 1, 2, and 3, and a common diet was fed to all pigs during Phase 4. Diets fed during Phase 1, Phase 2 and Phase 3 consisted of 1) the negative control (NC), 2) the NC + ACID, 3) the NC + LAC, and 4) the NC + ACID + LAC. The diets used as the negative control in Phase 1, Phase 2, and Phase 3 were formulated using corn, soybean meal, fish meal, blood plasma, and soy protein concentrate as sources of protein; and corn starch as a replacement for both LAC and ACID. The ACID was included at 0.75% of the diet, and LAC was included at 21, 14, and 7% respectively during Phase 1, Phase 2, and Phase 3. Performance criteria including ADG, ADFI, and G:F were measured for each phase of the experiment. In addition, medical treatments, and pig removals were recorded daily as measures of health status. The experimental treatments, did not affect ADG, ADFI, or health status. However, G:F was decreased ($P < 0.05$) in Phase 1, in Phase 2 and overall by inclusion of LAC. Neither lactic acid nor lactose improved growth performance in this study.

Diet	NC	ACID	LAC	ACID+LAC	SEM
ADG,g	347.9	355.8	348.8	347.1	4.1
ADFI, g	509.5	518.6	515.6	510.3	6.8
Gain /feed ^a	0.682	0.692	0.669	0.675	0.006

^aMain effect of LAC ($P < 0.05$)

Key Words: Pig, Lactic Acid, Lactose

170 Dietary lactose levels for weanling pigs. D. C. Mahan and N. D. Fastinger*, *The Ohio State University*.

Dietary lactose inclusion within the past decade has resulted in increased weanling pig gains and feed intakes during the initial phase postweaning. Three experiments evaluated various lactose levels (total) added to complex diets and fed to weaned pigs during Phase 1 (0-7 d), Phase 2 (7-21 d) and Phase 3 (21-35 d) postweaning. Lactose was added at the expense of corn starch in each trial with pigs weaned at 18 ± 1 d. Exp. 1 was a randomized complete block (RCB) design conducted in 8 replicates. Pigs (n= 240) weighing 6.3 kg were fed diets formulated to 1.55% total lysine. Lactose levels (n= 6) in 5% increments from 10 to 35% were evaluated for the 0 to 7 d period. Results demonstrated increased ($P < 0.05$) daily gains (84, 99, 103, 114, 130, 103 g, respectively) to lactose inclusion. Increased feed intake ($P < 0.12$), and gain:feed ($P < 0.01$) resulted as lactose increased. In Exp. 2 the pigs (n= 240) were initially fed a 25% lactose diet during Phase 1. Treatment diets formulated to 1.45% lysine (total) were fed from 7-21 d postweaning. Lactose levels (n = 5) added in 5% increments from 8 to 32% were evaluated. The experiment was an RCB conducted in 8 replicates. Pigs weighed 7.1 kg at 7-d postweaning. Daily gains increased ($P < 0.05$) as lactose (384, 396, 424, 426, 396 g, respectively) increased to 18%. Feed intake increased but not significantly ($P > 0.15$), but gain:feed ratio increased ($P < 0.05$) to 32% lactose. In Exp. 3, a 25% lactose diet followed by a 23% lactose diet was fed to pigs during Phase 1 and 2, respectively. At the 21 d period, pigs (n= 300) weighing an average 16.1 kg were allotted to treatment pens in a RCB design in 10 replicates. Dietary lactose levels (n=5) in 5% increments from 0 to 20% lactose were evaluated to 35 d postweaning. Diets contained 1.35% lysine (total). Daily gains increased and plateaued (673, 690, 692, 706, 697 g, respectively) to the 15% lactose level ($P < 0.05$). Feed intake increased ($P < 0.07$), with no effect on feed efficiency. These results suggest that total dietary lactose levels should be approximately 30% in Phase 1, 20% in Phase 2, and 15% in Phase 3.

Key Words: Wean, Lactose, Pigs

171 The effect of β -glucanase, xylanase and α -amylase combinations in barley-based diets on the performance of weaner pigs. M. J. Pettitt*¹, P. H. Simmins², and E. Beltranena¹, ¹*Prairie Swine Centre Inc.*, ²*Danisco Animal Nutrition*.

A study was conducted comparing 0.05% and 0.10% inclusion of a β -glucanase/xylanase product (Porzyme(r) 9100) and a similar product with also α -amylase at 0.10% inclusion (Porzyme(r) 8100) on the performance of pigs fed diets based on either Hoda (H) or Schmidt (S) barley varieties. Four hundred and eighty crossbred PIC pigs were randomly allocated, at 6 kg live weight, to two different nursery diets, which were formulated to be fed in two phases, 0-21 days and 21-42 days on test. The diets contained 610 g/kg and 690 g/kg barley and 200 g/kg and 250 g/kg soybean meal in Phase 1 and 2, respectively. Digestible lysine was 13 and 11 g/kg for Phase 1 and 2 respectively. Analyzed DE was 2967, 3158 (Phase 1) and 2823, 3038 (Phase 2) kcal/kg for the H and S barley diets, respectively. Feed disappearance was 0.651, 0.747, 0.676, 0.713, 0.665, 0.666, 0.735, 0.727 ($P=0.001$) for H: control, P9100 0.05, 0.10%, P8100 0.10%, S: control, P9100 0.05, 0.10%, P8100 0.10% treatments, respectively. Daily weight gain was 0.407, 0.472, 0.416, 0.456, 0.416, 0.413, 0.464, 0.458 ($P=0.001$) for H: control, P9100 0.05, 0.10%, P8100 0.10%, S: control, P9100 0.05, 0.10%, P8100 0.10% treatments, respectively. Gain:feed was not affected by treatment. Supplementation of diets with P9100 improved daily weight gain and feed disappearance overall optimal at 0.05% ($P=0.001$) for the H diet and 0.10% ($P < 0.001$) for the S diet. Supplementation of the H and S barley-based diets with 0.10% P8100 increased daily weight gain and daily feed disappearance ($P < 0.001$ and $P < 0.01$, respectively) overall compared with control. At the 0.10% inclusion level, the two enzyme products responded differently to the different barley under test. It might indicate that addition of α -amylase may be useful in some circumstances. More work is required at different inclusion rates. Optimal enzyme response and combination vary, dependent on the nutritional and antinutritional qualities of the barley in the diet.

Key Words: Pigs, Barley, Enzyme

172 Effect of wheat quality and xylanase supplementation on performance of weaned pigs fed pelleted diets. R. T. Zijlstra*¹, D. Overend², M. Schalm³, A. Owusu-Asiedu¹, P. H. Simmins⁴, and J. F. Patience¹, ¹*Prairie Swine Centre Inc.*, ²*Ridley Inc.*, ³*FeedRite*, ⁴*Danisco Animal Nutrition*.

Nutritional quality between wheat samples is influenced by protein and fiber content. Supplementation with a fiber-degrading enzyme may reduce the impact of wheat quality variance on pig performance. Six wheat samples representing a wide range in NDF (20.1 to 35.7% DM) and narrow range in CP (18.8 to 21.4% DM) were collected. Effects of wheat samples and enzyme treatments (control; *Trichoderma xylanase*, 2625 U/kg diet) on performance were investigated in a 6x2 factorial arrangement in 12 diets. Diets (3.5 Mcal DE/kg; 3.4 g dig. lysine/Mcal) contained wheat (65%), SBM (27%), canola oil (2.1%), and fishmeal (1.3%) as main ingredients were pelleted (72 °C; PDI 93-95). A 3-wk growth study was conducted with 12-kg weaned pigs (PIC; 39-d-old; 4 pigs/pen, 12 pens per diet). For d 0 to 7, wheat affected ADG and feed efficiency ($P < 0.01$). Enzyme improved ADG and feed efficiency ($P < 0.05$). However, wheat and enzyme interacted ($P < 0.05$), because pigs responded positively to enzyme for five wheats ($P < 0.01$; +0.26 kg at d 7) and negatively for one wheat ($P < 0.05$; -0.30 kg). Wheat and enzyme did not affect ADFI ($P > 0.10$). For d 8 to 14, ADG and feed efficiency were not affected by wheat or enzyme ($P > 0.10$) but ADFI was affected by wheat x enzyme ($P < 0.01$), producing 0.36 kg heavier pigs from enzyme-supplemented diets ($P < 0.05$). For d 15 to 21, ADG and ADFI were not affected by wheat or enzyme ($P > 0.10$) and wheat affected feed efficiency ($P < 0.05$). For d 0 to 21, ADG was not affected by wheat or enzyme ($P > 0.10$), ADFI was affected by wheat x enzyme ($P < 0.05$), and feed efficiency was affected by wheat ($P < 0.01$) and improved 2% by enzyme ($P < 0.05$), resulting overall in 27-kg pigs. In summary, wheat quality affects performance of weaned pigs and specific wheat samples may affect the response by pigs to enzyme supplementation. Wheat quality should be analyzed prior to diet formulation and processing to achieve a predictable performance.

Key Words: Wheat, Pig, Enzyme

173 Comparison of 75 vs 150 mg/kg vitamin C in two nursery environments. B. V. Lawrence*, J. Hedges, S. A. Hansen, and J. D. Hahn, *Hubbard Feeds Inc.*

Two 21-d experiments were conducted with Compart Boar Store Line 442 X D100 Duroc pigs weighed on days 0, 7, and 21. In Exp. 1, 981 Unit A pigs (5.43 ± 0.32 kg) were allotted to a starter diet with either 75 or 150 mg/kg supplemental vitamin C (Stay-C[®]). Pigs were housed in 2.44 X 2.44 m pens in a conventional nursery with 25 pigs/pen. Pigs were ad libitum fed from a fenceline feeder (3.6 linear cm/pig) and with water available from 2 nipples and 1 cup per pen. There were no differences ($P > 0.10$) in day 0 - 21 growth performance. Pigs gained 146.6 ± 39.2 g/d day 0 to 7, and 399.6 ± 29.1 g/d from day 7 to 21. Gain to Feed (GF) was 0.92 ± 0.17 during the first 7-d and 0.89 ± 0.11 from day 7 to 21. Overall ADG was 314.2 ± 28.5 g/d with a GF of 0.89 ± 0.09 . Pigs removed as a result of morbidity and mortality was 0.91% in Exp. 1. In Exp. 2, a total of 1,991 Unit B pigs (6.68 ± 0.79 kg) were allotted to the same diets as Exp. 1. Pigs were housed in 3.17 X 5.48 m pens in a commercial tunnel ventilated wean-to-finish facility, double stocked with 56 pigs/pen. Pigs had ad libitum access to feed from a fenceline feeder (2.5 linear cm/pig) and access to water via 2 nipples and 1 cup per pen. Day 0 - 21 growth performance was not different ($P > 0.10$) between treatments. ADG was substantially less in Exp. 2 than ADG observed in Exp 1. despite similar health status and health management protocols between pig sources. In Exp. 2, ADG day 0 - 7 was 45.1 ± 13.2 g/d with a GF of 0.51 ± 0.15 while day 7 - 21 ADG and GF were 250.7 ± 45.5 g/d and 0.70 ± 0.12 respectively. Cumulative ADG and GF during Exp. 2 were 182.1 ± 30.9 g/d and 0.68 ± 0.11 . Pigs removed as a result of morbidity and mortality was numerically reduced from 2.1% to 1.7%, as level of added vitamin C increased from 75 to 150 mg/kg, irrespective of site. These results highlight the challenges of weaning pigs into wean-finish facilities and indicates that increasing the added Vitamin C level to 150 mg/kg may not be beneficial in complex starter diets even under different management scenarios.

Key Words: Vitamin C, Performance, Pigs

174 Effect of supplemental nucleosides for newly weaned pigs. C. D. Mateo*, R. I. Dave, and H. H. Stein, *South Dakota State University*.

An experiment was conducted to determine the effects of adding nucleosides to diets for weaning pigs. Thirty six pigs were weaned at 16 to 29 d of age and allotted to one of three treatment (Trt) groups with two pigs/pen and six replicate pens/treatment group. Pigs allotted to Trt 1 were fed a corn-casein-lactose-based basal diet (Diet 1). Pigs allotted to Trt 2 were fed the basal diet supplemented with 0.002% adenosine, 0.001% cytidine, 0.004% guanosine, 0.0005% inosine, and 0.047% uridine (Diet 2). Pigs allotted to Trt 3 were fed the basal diet supplemented with 0.012% adenosine, 0.006% cytidine, 0.019% guanosine, and 0.002% inosine, and 0.236% uridine (Diet 3). Diets were fed for 2 wk post-weaning. Blood and fecal samples were collected on d 0, 7, and 14. The concentration of IgG was determined in the serum while microbial concentrations were determined in fecal samples. On d 7, pigs fed Diet 1 had higher ($P < 0.05$) fecal count of *Cl. perfringens* compared with pigs fed Diet 3 (6.08 vs. 5.04 \log_{10} cfu/g). On d 14, the concentration of *Cl. perfringens* was different ($P < 0.05$) among all treatments (4.76, 4.26, and 3.00 \log_{10} cfu/g for Diets 1, 2, and 3, respectively). On d 14, the fecal concentration of *L. acidophilus* was higher ($P < 0.05$) in pigs fed Diet 2 compared with pigs fed Diet 1 (9.32 vs. 8.82 \log_{10} cfu/g). Pigs fed Diet 2 also had higher ($P < 0.05$) counts of *Bifidobacterium spp.* compared with pigs fed Diet 1 (8.35 vs. 7.68 \log_{10} cfu/g). Pigs fed Diet 3 had counts of *L. acidophilus* and *Bifidobacterium spp.* that were not different from pigs fed the other treatment diets (9.20 and 8.32 \log_{10} cfu/g, respectively). No differences among treatment groups were observed for total coliforms or for *E. coli*. Serum IgG concentrations increased ($P < 0.004$) with time after weaning, but there were no differences among treatment groups. The results of the experiment indicate that nucleoside supplementation during the immediate post-weaning period may positively influence the gastrointestinal microflora by decreasing *Cl. perfringens* and increasing *L. acidophilus* and *Bifidobacterium* species.

Key Words: Microflora, Nucleosides, Piglets

175 Evaluation of feed budgeting effects on performance of 6-25 kg pigs. J. D. Hahn*, S. A. Hansen, and B. V. Lawrence, *Hubbard Feeds, Inc.*

The effects from feed budget options, 1 to 9 days post-weaning, on subsequent pig performance in the nursery period was studied. A total of 896 PIC pigs (C22 x TR4) 5.6 kg \pm 0.37 kg were allotted to four treatment regimens (n=8), in a conventional nursery, at 28 pigs/pen. A common set of three diets was utilized, providing 1.5, 1.4 and 1.3% Lys for Phases 1, 2 and 3, respectively. The Phase 1 diet was fed for 3, 5, 7 or 9 days post-weaning, resulting in treatments P1-3, P1-5, P1-7 and P1-9, respectively. All treatments received Phase 2 starter for 12 days subsequent to the Phase 1 period. After completing the Phase 2 period, all pigs were fed a Phase 3 diet until d 47 post-weaning. For the 0-9 day period, increasing the budget for the Phase 1 diet from 3 to 9 days resulted in a linear ($P < 0.05$) increase in ADG, ADFI and GF. For the 0-21 day period, increasing the Phase 1 feeding period resulted in a linear ($P < 0.05$) increase in ADG, ADFI, but resulted in a similar GF response. For the 0-47 day period, increasing the Phase 1 feeding period resulted in no significant responses for any parameter. At d 47, pigs on the P1-5 and P1-9 treatments retained the numerical BW advantage over pigs on the P1-3 treatment, consistent with the advantage in BW present at d 21. At d 47, pigs on the P1-7 treatment, however, retained less than half of the BW advantage over pigs on the P1-3 present at d 21. Increasing the amount of Phase 1 starter had a significant impact on 0-21 day nursery pig performance, but overall performance of 6-25 kg pigs was not improved ($P > 0.10$) for any parameter.

Trt Period	P1-3	P1-5	P1-7	P1-9	CV	Trt P<	Linear P<
Day 0-9							
ADG, g	246.6	260.6	267.3	276.8	7.5	.040	.040
ADFI, g	199.1	245.5	237.8	244.6	7.2	.001	.001
Gain/feed, g/g	1.25	1.06	1.12	1.13	7.5	.003	.003
Day 0-21							
ADG, g	305.4	320.1	329.1	340.4	7.7	.060	.008
ADFI, g	350.4	365.7	392.2	381.8	6.1	.006	.003
Gain/feed, g/g	.87	.88	.84	.89	4.1	.050	NS
Day 0-47							
ADG, g	435.1	442.5	439.3	452.6	5.7	NS	NS
ADFI, g	597.6	602.2	606.6	619.4	6.7	NS	NS
Gain/feed, g/g	.73	.74	.72	.73	2.3	NS	NS
End Wt., kg	26.02	26.34	26.24	26.87	8.1	NS	NS

Key Words: Nursery Pigs, Feed Budget, Growth

176 Pre-planned segregation: The effect of grouping by weight at weaning on variability in body weight at nursery exit. J. F. Patience*, H. W. Gonyou, R. T. Zijlstra, and A. D. Beaulieu, *Prairie Swine Centre, Inc.*

Variability in pig growth is emerging as a critical issue in the success of individual pork producers. It represents a cost to producers due to sort losses at marketing and reduced barn utilization. Pre-planned segregation, the separation of the total population of pigs into sub-groups that are expected to differ in growth, is one option available to producers for managing variability. The objectives of this experiment were to develop a better understanding of variability in weaning pigs and to determine if uniformity of growth of the total population could be improved using pre-planned segregation by BW at weaning. All available pigs from 8 weeks of farrowings (n=2080; 16 pens per week) were used for the experiment. Three sorting regimes were compared; unsorted (UN), 50:50 sort (S50, segregating the heavier half of the pigs from the lighter half), and 12:88 sort (S12, segregating the lightest 12% from the heavier 88%). The pigs were individually identified and weighed at weaning (d0) and on days 8, 18, 28, 39 and 50 post-weaning. Initial (5.95 ± 0.12 , mean \pm SE) and final (31.47 ± 0.33) BW were similar ($P > 0.05$) regardless of sorting regime. ADG was not improved in the overall population by segregation ($P > 0.05$). The coefficient of variation (CV), determined using individual pig weights, averaged $19.94 \pm 0.87\%$ on d 0 and $13.95 \pm 0.62\%$ on d 50 and was unaffected in the overall population by sorting at weaning ($P > 0.05$). The CV of the 12th or the 50th percentile at d 50 ($11.77 \pm 1.30\%$; $12.50 \pm 0.68\%$, respectively) was similar ($P > 0.05$) regardless of whether 0%, 12% or 50% of the lightest pigs had been physically separated at weaning. In conclusion, segregating either the 12% or 50% lightest pigs at weaning did not result in increased variability of the remaining group; the BW of sorted pigs did not "spread out" upon the removal of sub-groups. This indicates that the implementation of pre-planned segregation would allow producers to market rooms of heavier pigs sooner, thus improving barn utilization.

Key Words: Variability, Weanling Pig, Nursery

177 Effect of weaning age and commingling after the nursery phase on immune characteristics of pigs in a wean-to-finish facility. M. E. Davis, C. V. Maxwell, J. K. Apple, Z. B. Johnson, S. C. Arthur, and D. C. Brown, *University of Arkansas*.

A total of 216 pigs were weaned at 14 or 21 d of age to determine the effect of weaning age and commingling after the nursery period on immune measurements of pigs in a wean-to-finish facility. Pigs were divided into older and younger age groups (108 pigs/group) and penned 12 pigs/pen (1.5 X 3 m) in a wean-to-finish facility with 9 replications of each age group during the nursery phase. At the end of the nursery phase, half of the pigs in each age group were removed, re-randomized, and commingled for the finishing phase, whereas the other half of the pigs remained in their original pens. Plasma was obtained on d 0, 2, 10, 27, 37, 44, and 65 after weaning to determine leukocyte concentrations. Lymphocyte proliferation was determined on d 10 and 44. Older pigs had a greater ($P \leq 0.10$) concentration of white blood cells (WBC), neutrophils (NEU) and lymphocytes (LYM) on d 0 and d 2, and greater ($P \leq 0.06$) [WBC] and [LYM] on d 10 than younger pigs. On d 37, [WBC] and [LYM] were increased ($P \leq 0.05$) when older pigs were commingled compared to older pigs that were not commingled, whereas there were

no differences as a result of commingling younger pigs (interaction, $P \leq 0.07$). On d 37, [NEU] were greater ($P < 0.08$) as a result of commingling. On d 65, NEU as a percentage of WBC were greater ($P \leq 0.05$) in younger pigs compared to older pigs, whereas the percentage of LYM was greater ($P \leq 0.05$) in older pigs compared to younger pigs. On d 44, lymphocytes from younger pigs had greater ($P \leq 0.05$) unstimulated proliferation than LYM from older pigs. Lymphocyte proliferation in response to pokeweed mitogen increased during the finishing period when younger pigs were commingled compared to younger pigs that were not commingled, whereas proliferation decreased in older pigs as a result of commingling (interaction, $P \leq 0.01$). Leukocyte concentrations from pigs weaned at 21 d of age respond more to the social stresses of weaning and commingling than pigs weaned at 14 d of age, although younger pigs become more immunologically responsive in the later growing stages.

Key Words: Swine, Management, Leukocytes

178 Effect of weaning age and commingling after the nursery phase on growth performance of pigs in a wean-to-finish facility. M. E. Davis*, C. V. Maxwell, J. K. Apple, Z. B. Johnson, and S. C. Arthur, *University of Arkansas*.

A total of 216 pigs were weaned at 14 or 21 d of age to determine the effect of weaning age and commingling after the nursery phase on growth performance of pigs in a wean-to-finish facility. Pigs were divided into older and younger age groups (108 pigs/group) and penned 12 pigs/pen (1.5 X 3 m) in a wean-to-finish facility with 9 replications of each age group. Pigs were fed common Phase 1 (d 0 to 14) and Phase 2 (d 14 to 34) diets. Older pigs had greater ($P \leq 0.01$) ADG and ADFI during the overall nursery period; however, younger pigs had greater ($P \leq 0.01$) G/F during Phase 2. Older pigs were heavier ($P \leq 0.01$) throughout the nursery period and BW difference increased from 2 kg to 6.5 kg at the start and end of the nursery period. At the end of the nursery phase, half of the pigs in each age group were removed, re-randomized, and commingled for the finishing phase, whereas the other half of the pigs remained in their original pens. Pigs were fed a four-phase common diet with transitions at 45, 68, and 90 kg. The study was terminated when pigs averaged 107 kg. During Phase 3 and the overall finishing phase, younger pigs had greater ($P \leq 0.01$) ADG and G/F than older pigs. During Phase 3, ADFI decreased ($P \leq 0.05$) when older pigs were commingled compared to older pigs that were not commingled, whereas there was no difference in ADFI of younger pigs regardless of whether or not they were commingled (interaction, $P \leq 0.08$). In the overall Phase 1-3 period, younger pigs had greater ($P \leq 0.10$) G/F when they remained in their original pens compared to younger pigs that were commingled; however, there was no difference in G/F of older pigs regardless of whether or not they were commingled (interaction, $P \leq 0.05$). In conclusion, pigs weaned at 14 d of age grew slower than pigs weaned at 21 d of age during the nursery phase; however, younger pigs gained more than older pigs later in the finishing period. Commingling of pigs following the nursery phase did not affect ADG; however, the effects of commingling on ADFI and G/F were dependent on age of pigs at weaning.

Key Words: Swine, Management, Growth

179 Bioavailability of phosphorus in roller-dried whey and Dairylac[®]-80 for growing pigs. G. L. Cromwell*¹, L. A. Pettey¹, E. G. Xavier¹, M. D. Lindemann¹, and K. M. Halpin², ¹*University of Kentucky*, ²*International Ingredient Corp.*

A 28-d experiment was conducted to determine the bioavailability of P in roller-dried whey (DW) and Dairylac[®]-80 (DL-80, a granular, nonhygroscopic product produced from dried sweet whey solubles) for young pigs. The DW and DL-80 analyzed 0.66 and 0.70% P, and 75 and 83% lactose, respectively. Four pens of two pigs/pen (11.0 kg BW) were fed on each of five diets. Diet 1 was a low-P (0.32%) basal consisting of 35% corn, 30% soybean meal, 12% starch, and 18% lactose and fortified with amino acids, minerals (except P), and vitamins. In Diets 2 and 3, monocalcium phosphate (MCP) was added to the basal to provide 0.10 and 0.20% P. In Diets 4 and 5, DW and DL-80 were added at 22.8 and 21.4% (substituted for starch and lactose), which provided 0.15% added P. All diets contained 1.16% lysine, 0.73% Ca, 17.7% lactose, and 3,425 kcal ME/kg. At termination, all pigs were killed and the femurs and third and fourth metacarpals and metatarsals (MM) were collected. Ten additional pigs (10.6-13.6 kg BW) were killed at the start of the test

to assess initial bone traits so as to estimate accretion of bone strength and ash. ADG, ADFI, and feed:gain for treatments 1-5 were ($P < 0.05$): 396, 549, 688, 641, 623 g/d; 808, 957, 1111, 1110, 1030 g/d; and 2.04, 1.75, 1.61, 1.73, 1.66, respectively. Femur strength, MM strength, and MM ash were affected ($P < 0.05$) by diet (51, 99, 164, 130, 115 kg; 19, 35, 46, 44, 38 kg; 1.14, 1.55, 1.97, 1.94, 1.71 g/bone). Accretion of femur and MM strength and MM ash followed similar trends (-20, 27, 93, 56, 42 kg; -3, 13, 24, 22, 16 kg; 0.25, 0.66, 1.08, 1.03, 0.81 g/bone). Body weight gain and bone traits were regressed on level of added P intake and slopes of DW and DL-80 were divided by the slope of MCP for each trait. Based on slope-ratio of weight gain, the bioavailability of P was 116% for DW and 120% for DL-80. Based on the bone traits, the mean bioavailability of P was 119% for DW and 100% for DL-80. The results indicate that the P in the two whey products is highly available for growing pigs.

Key Words: Pigs, Phosphorus, Whey

180 Estimation of endogenous phosphorus loss in growing-finishing pigs. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky*.

Thirty-six barrows were used in a series of three P balance experiments in growing-finishing pigs fed highly digestible, semi-purified diets at or below the dietary available P requirement to estimate the effect of body weight on endogenous P loss. Exp. 1, 2, and 3 were conducted with pigs averaging 27, 59, and 98 kg BW, respectively. In each experiment, pigs were placed in metabolism crates and allotted by weight and litter to three dietary treatments. Diets were: (1) a sucrose-dextrose-cornstarch-casein-based diet with no added P; (2) as 1 with 0.07 (Exp. 2 and 3) or 0.08% (Exp. 1) added P from monosodium phosphate (MSP); and (3) as 1 with 0.13 (Exp. 2 and 3) or 0.16% (Exp. 1) added P from MSP. Pigs were fed twice daily equal amounts of feed within replicate. Pigs were adjusted to treatments for 7 d prior to a 6-d marker-to-marker collection of feces and urine. Feed intake averaged 98, 96, and 102% of ad libitum (NRC, 1998) for Exp. 1, 2, and 3. P intakes (g/d) for pigs fed Diets 1, 2, and 3 were: (Exp. 1) 1.73, 2.83, and 3.91; (Exp. 2) 2.18, 3.69, and 5.32; (Exp. 3) 1.96, 4.26, and 6.26. Fecal P excretion and P absorption increased linearly ($P < 0.01$) with increasing P intake. At each body weight, urinary P excretion (g/d) was low for Diet 1 (0.01, 0.01, 0.02) and 2 (0.01, 0.06, 0.08), and for Diet 3 in 27 kg pigs (0.04), but increased ($P < 0.01$) for Diet 3 in 59 and 98 kg pigs (0.55 and 0.49). When P absorption (g/d) was regressed on P intake in Exp. 1, 2, and 3 the relationships were linear ($P < 0.01$) with $Y = -0.110 + 0.971X$ ($R^2 = 0.999$), $Y = -0.156 + 0.939X$ ($R^2 = 0.998$), and $Y = -0.226 + 0.891X$ ($R^2 = 0.982$), respectively. Thus, our estimates of endogenous P loss at zero P intakes are 110, 156, and 226 mg/d for 27, 59, and 98 kg pigs, respectively. When these y-intercepts were regressed on body weight the relationship was $Y = 63.284 + 1.635X$ ($R^2 = 0.996$). Based on these data, we estimate the endogenous P loss of pigs fed highly digestible, semi-purified diets to increase by approximately 1.64 mg for each kg increase in body weight from 25 to 100 kg BW.

Key Words: Phosphorus, Endogenous Loss, Pigs

181 Prediction of phosphorus requirements utilizing phosphorus accretion in whole empty body of growing-finishing pigs. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky*.

A comparative-serial slaughter experiment was conducted to determine whole empty body (WEB) composition and accretion rate of P in growing-finishing pigs. Five sets of five littermate barrows (37 kg) were allotted to five slaughter groups (39, 56, 73, 92, and 109 kg BW). Pigs were fed corn-SBM diets during three phases (36-55, 55-73, and 73-109 kg BW; 0.91, 0.80, 0.71% lysine; 0.57, 0.54, 0.51% P). At assigned BW, pigs were killed and separated into body components of hair, toenails, blood, head, empty viscera, and carcass. Carcasses were split with the left side ground for analysis and the right side separated into soft tissue (lean and fat), skin, and bone. The viscera, head, and other body components also were ground for analysis. Weight and accretion rates of WEB, N, ash, and P were determined for each body component. Whole body composition of pigs in each BW group were: WEB: 35.5, 51.3, 67.9, 86.5, 103.6 kg; N: 968, 1376, 1878, 2236, 2748 g; ash: 834, 1245, 1748, 2202, 2572 g; P: 153, 220, 304, 381, 466 g. Dissected bone for each group was: 3.55, 4.50, 5.92, 6.81, and 8.20 kg, or 10.0, 8.8, 8.7, 7.9, and

7.9% of WEB, respectively. The data were combined with those from a previous study with 18-54 kg BW pigs (JAS 81[Suppl 2]:62; 2003). The relationship of WEB N to P was linear ($P < 0.01$) with $Y = 28.092 + 5.822X$ ($R^2 = 0.979$). The linear ($P < 0.01$) relationships of live BW to the weight of WEB, N, and P were used to estimate the accretion rates of WEB, N, and P from 18-36, 36-55, 55-73, 73-91, and 91-109 kg BW. Accretion rates were: WEB: 674, 938, 1042, 1075, 859 g/d; N: 18.3, 25.4, 28.3, 29.2, 23.3 g/d; P: 3.09, 4.31, 4.78, 4.93, 3.94 g/d. The P accretion rate was $Y = -0.07236 + 0.14337X - 0.001028X^2$ ($R^2 = 0.983$) and was linearly ($P < 0.01$; $R^2 = 0.999$) related to fat-free lean tissue accretion rate. From these data, WEB P increased at a rate of 1 g for every 5.8 g increase in WEB N (or 36.25 g of WEB protein); thus the daily P requirement for maximum P retention could be predicted from the fat-free lean tissue accretion rates of growing-finishing pigs.

Key Words: Body Composition, Phosphorus, Pigs

182 Evaluation of the available phosphorus requirement and phosphorus balance in pigs from 50 to 90 kg. R. W. Fent^{*1}, S. X. Fu¹, B. W. Ratliff¹, D. M. Webel², J. D. Spencer², and G. L. Allee¹, ¹University of Missouri, ²United Feeds Inc.

Two experiments were conducted to evaluate the effects of available phosphorus (aP) concentration or phytase inclusion in diets for 50 to 90 kg pigs. Pigs used in this study had been fed dietary aP levels previously determined in our lab to maximize bone mineralization (0.41% for 9-24 kg; 0.32% for 24-50 kg). In Exp. 1, 180 pigs (initial wt=50 kg) were allotted to one of six dietary treatments in a completely randomized design with five replications per treatment. Diets (0.80% true digestible lysine and 1.2:1 calcium:total phosphorus) were corn-soybean meal-based and formulated to contain 0.06, 0.12, 0.18, 0.24, or 0.30% aP through the addition of monosodium phosphate. The sixth treatment consisted of the basal diet with 500 FTU/kg EcoPhosTM phytase. Pigs were terminated at an average body weight of 90 kg and third metacarpals were collected for analysis. Although average daily gain tended ($P = 0.06$) to increase linearly with increasing aP, maximum gain and efficiency occurred at 0.18% aP. Bone breaking load and bone ash content increased quadratically ($P < 0.05$) with increasing aP. The phytase diet resulted in similar growth and bone parameters as the higher aP treatments and had the greatest gain:feed ($P < 0.05$). In Exp. 2, three of the dietary treatments from Exp. 1 (0.18% aP, 0.30% aP, and 0.06% aP + 500 FTU/kg EcoPhosTM) were fed to individual pigs (initial wt=71 kg) in a total collection experiment with eight replications per treatment to measure phosphorus (P) balance. Pigs were allowed a 5-d adjustment to the diets followed by a 3-d collection. Fecal P excretion (DM basis) was greatest ($P < 0.05$) in pigs fed 0.30% aP and least ($P < 0.05$) for pigs fed the phytase diet. Retention of P was greatest ($P < 0.05$) in pigs fed the phytase diet as compared to those fed 0.18% or 0.30% aP. These results demonstrate that feeding aP levels above the animal's requirement does not improve growth performance and results in a 22% increase in total P excretion. Supplementation with 500 FTU/kg EcoPhosTM resulted in a further 44% reduction in P excretion with no effect on gain and an improvement in feed efficiency.

Key Words: Phosphorus, Phytase, Pigs

183 Evaluation of reducing dietary phosphorus concentration during the finishing period following bone loading to 50 kg BW. R. W. Fent^{*1}, S. X. Fu¹, B. W. Ratliff¹, D. M. Webel², J. D. Spencer², and G. L. Allee¹, ¹University of Missouri, ²United Feeds Inc.

Two experiments were conducted to examine the available phosphorus (aP) requirements and the effects of strategies to reduce phosphorus excretion in the diets of pigs weighing 90 to 122 kg. Pigs used in this study had been fed dietary aP levels previously determined in our lab to maximize bone mineralization from 9-24 kg (0.41%) and 24-50 kg (0.32%). The aP level (0.19%) fed from 50-90 kg body weight was as recommended by NRC (1998). In Exp. 1, pigs ($n = 190$) were allotted to one of five dietary treatments in a completely randomized design with five replications per treatment. Diets (0.65% true digestible lysine, 1.2:1 calcium:total phosphorus) were corn-soybean meal-based and consisted of aP concentrations of 0.05, 0.10, 0.15, 0.20, and 0.25% achieved through the addition of monosodium phosphate. Pigs were shipped to a commercial processing facility at an average body weight of 120 kg and third metacarpals were collected for analysis. The plant observed no

incidences of broken spines or aitchbones during processing. Although average daily gain increased linearly ($P < 0.05$), little improvement occurred above 0.15% aP. Gain:feed and bone breaking load were similar ($P > 0.05$) across dietary treatments. However, bone ash increased linearly ($P < 0.05$) with increasing dietary aP. In Exp. 2, individual pigs (initial wt=105 kg) were utilized in a total collection experiment to evaluate the phosphorus (P) balance of pigs fed diets containing 0.15% aP, 0.25% aP, and 0.05% aP + EcoPhosTM phytase with eight replications per treatment. Pigs fed the phytase diet had the greatest ($P < 0.05$) P absorption and retention, as a percentage of P intake, as compared to those fed 0.15% or 0.25% aP. Total P excretion was lower ($P < 0.05$) in pigs fed 0.15% aP as compared to those fed 0.25% aP. These results indicate maximization of bone mineralization up to 50 kg will allow for the feeding of 0.15% aP from 90 to 122 kg without sacrificing growth, efficiency, or bone strength. The 0.15% aP and EcoPhosTM diets resulted in 17% and 55% reduction in total P excretion, respectively, as compared with the 0.25% aP.

Key Words: Phosphorus, Phytase, Pigs

184 Meat quality and pig performance influenced by chromium propionate. B. V. Lawrence^{*1}, D. Overend¹, S. A. Hansen¹, J. D. Hahn¹, and R. Odgaard², ¹Hubbard Feeds Inc., ²Kemin Americas.

A total of 510 Duroc barrows and gilts (Compart Boar Store Line 442 X D100) weighing 29.7 ± 0.7 kg were allotted to a corn-soybean meal diet (CTRL) or the CTRL diet + 200 ppb Cr from Kem-TRACE[®] Cr (Cr). Pigs were weighed on d 0, 21, 35, 49, 63, 77 and 91. Gain day 0 to 77 did not differ ($P > 0.10$), however, from d 77 to 91 gain was greater ($P < 0.01$) for the Cr pigs (645 vs. 531 g/d) resulting in a trend ($P < 0.10$) for Cr to improve cumulative gain (804 vs. 783 g/d). Cumulative gain of gilts was affected to a greater extent by Cr than gain of barrows ($P < 0.05$). Cumulative G:F was greater ($P < 0.05$) for Cr fed pigs (0.401 vs. 0.388) primarily as a result of a greater ($P < 0.01$) G:F for Cr pigs from day 77 to 91 (0.309 vs. 0.266). On day 91, 35 gilts per treatment were individually tagged, tattooed, and weighed (110.4 ± 7.5 kg) prior to shipment. Due to random selection of pigs, farm live weight was greater for Cr fed pigs and was used as a covariate. After 8-h transit to a commercial packer, hot carcass weights (HCW) were obtained (83.0 ± 2.1 kg). After adjustment for live weight, HCW and Yield ((HCW)/Farm weight)*100 were not different ($P > 0.10$). There was, however, numerically less difference between the farm weight and the HCW for the Cr-fed pigs (diff = 0.7 kg). Fat depth, muscle depth and percent lean were not different ($P > 0.10$). Loin and ham pH were measured at 1 and 22-h post-mortem. Loin pH was not different ($P > 0.10$) at either time point. Ham pH was similar at 1-h but higher ($P < 0.01$) at 22-h post-mortem for Cr-fed pigs (5.80 vs. 5.68). There was no difference in drip loss ($P > 0.10$) between treatments. NPPC measures of loin color, firmness, marbling, as well as ColorTec L*, A*, and B* values were not different ($P > 0.10$). Slight numerical improvements ($P = 0.11$) in loin firmness (2.31 vs. 2.07) and marbling (2.78 vs. 2.49) were detected for the Cr-fed pigs. These results suggest long-term Cr propionate supplementation may improve pig growth and meat quality when fed during the entire finishing phase.

Key Words: Chromium Propionate, Meat Quality, Pig Growth

185 Effect of phytase and(or) removing the trace minerals from the diet on growth performance and bone mineral content in nursery pigs. J. L. Shelton^{*}, F. M. LeMieux, L. L. Southern, and T. D. Bidner, Louisiana State University.

Two experiments were conducted to determine the interactive effects of phytase (PHY) and removing the trace mineral premix (TMP) in diets for nursery pigs. Pigs (initial and final BW of 5.5 and 16.2 [Exp. 1] or 5.4 and 16.3 [Exp. 2] kg) were allotted to four treatments with eight (Exp. 1) or six (Exp. 2) replications of six or seven pigs per replicate in a randomized complete block design. The four dietary treatments were: with and without the TMP removed and with or without PHY (600 phytase units/kg; 622 units by analysis) in a 2 x 2 factorial. The Ca and aP levels were reduced by 0.10% in diets with added PHY. The TM provided in ppm; 127 Zn, 127 Fe, 20 Mn, 13 Cu, 0.8 I, and 0.3 Se. The diet provided in ppm; 33 Zn, 165 Fe, 19 Mn, 9 Cu, 0 I, and 0.22 Se. At the end of Phase 3, tails were removed from two pigs per replicate to determine bone ash percentage and mineral content. In Exp. 1, overall ADG and ADFI were decreased in pigs fed the diet without the

TMP, but PHY reversed these responses (PHY x TMP, $P < 0.02$). Skin lesions occurred on 26 of the 52 pigs fed the diets without the TMP but no pigs fed any other diet had skin lesions. Bone Fe and Zn levels were increased ($P < 0.03$) in pigs fed the diets with PHY. Bone ash percentage was increased in pigs fed the diet without TMP but PHY reversed this response (PHY x TMP, $P < 0.07$). Bone Zn levels were decreased ($P < 0.09$) in pigs fed the diets without the TMP. In Exp. 2, pigs fed the diets with the TMP removed had a decreased ($P < 0.10$) overall ADG and ADFI. Bone Cu and Zn levels were decreased ($P < 0.04$) in pigs fed the diets without the TMP, but bone Zn levels were increased ($P < 0.01$) in pigs fed the diet with PHY. Bone Mn levels were increased when PHY was added to the diet with the TMP and in the diet without the TMP, but when PHY was added to the diet without the TMP, bone Mn levels were decreased (PHY x TMP, $P < 0.01$). These data indicate that removing the TMP in diets for nursery pigs has negative effects on growth performance and bone mineral content, but the addition of PHY reversed these responses.

Key Words: Phytase, Pigs, Trace Mineral

186 The effects of dietary calcium source and level on growth performance, *E. coli* shedding, and gastric pH and buffering capacity in nursery pigs. L. Peddireddi*, A. L. Yager, K. L. Saddoris, L. M. Wilson, M. C. Walsh, D. M. Sholly, R. B. Hinson, B. T. Richert, and J. S. Radcliffe, *Purdue University*.

One hundred twenty weanling pigs were used in a 4-wk nursery experiment to evaluate the effects of dietary Ca source and level in nursery pig diets. Pigs were weaned (avg=17.6 d), blocked by BW and sex and randomly assigned to a 2X3 factorial design, with two levels of Ca (73 and 100% of NRC) and three sources of supplemental Ca (Ca carbonate, Ca lactate, and Ca sulfate). Two barrows and two gilts were housed per pen with 6 pens/trt. Phase 1 diets (.75/.55% Ca, .52/.38% aP) were fed for d 0-14, and Phase 2 diets (.70/.50% Ca, .49/.35% aP) were fed for d 14-28. Individual BW and pen feed intakes were recorded weekly. At the end of each phase a fresh fecal sample was collected from each pen (2 pigs/pen) to determine fecal pH and *E. coli* shedding. At the end of the trial, one barrow and one gilt/pen were killed and stomach digesta was collected to determine pH and titration value (TV; meq of NaOH/kg to pH 8 - meq of HCl/kg to pH 4). During Phase 1, ADG, ADFI, and G:F were unaffected ($P > .10$) by dietary Ca source or level. During Phase 2, dietary Ca source had no effect ($P > .10$) on ADG, ADFI, or G:F. Pigs fed 100% NRC Ca in Phase 2 had higher ADG ($P < .05$) and ADFI ($P < .01$) than pigs fed 73% NRC Ca diets, but G:F was unaffected ($P > .10$). Dietary Ca source had no effect ($P > .10$) on fecal *E. coli* shedding. Higher levels of dietary Ca tended ($P < .10$) to decrease fecal *E. coli* shedding during Phase 1, but not during Phase 2 ($P > .10$). Fecal pH was unaffected ($P > .10$) by Ca source and level. Dietary Ca level had no effect on stomach digesta pH, but stomach digesta TV ($P < .05$) was higher for pigs fed the 100% NRC Ca diets. Stomach digesta TV were unaffected ($P > .10$) by dietary Ca source, but gastric pH values were affected ($P = .05$) by Ca source with pigs fed diets with Ca sulfate < Ca lactate < Ca carbonate. In summary, altering the source and level of dietary Ca impacted dietary pH and buffering capacity, which affected nursery pig performance, gastric pH and buffering capacity.

Key Words: Calcium, Buffering Capacity, pH

187 Effects of dietary iron supplementation on growth performance and iron status indices of nursery pigs. M. J. Rincker*, G. M. Hill, J. E. Link, M. M. Martinez, A. M. Meyer, J. Peng, and J. E. Rowntree, *Michigan State University*.

Many common dietary ingredients contain substantial amounts of iron (Fe), causing typical nursery diets to exceed the postweaning Fe requirement. Questions arise as to the availability of this Fe and whether a potential toxicity exists from its oxidative capabilities. The objective of this experiment was to evaluate the effects of ferrous sulfate supplementation in typical nursery diets on growth performance and iron status indices. Crossbred pigs ($n = 225$; 6.53 kg; 19 ± 3 d) were randomly allotted by body weight, litter, and gender to one of five dietary treatments (5 pigs/pen; 9 pens/trt) and fed in three dietary phases (P1: d 1-7; P2: d 8-21; P3: d 22-35). The basal diet met or exceeded NRC recommendations (1998), excluding Fe, and was supplemented with 0, 25, 50, 100, or 150 ppm Fe. Pig weights and feed disappearance were determined for each phase to calculate ADG, ADFI, and G:F. Pigs were bled

on d 1, 8, 22, and 35 to determine hemoglobin, hematocrit, and plasma minerals. Thirty randomly chosen pigs (6 pigs/trt) were euthanized at study termination to determine final body composition. Growth performance was not affected by treatment. Pigs fed 50, 100, or 150 ppm added Fe had greater ($P < 0.05$) hemoglobin concentration on d 35 than those fed 0 or 25 ppm (11.8, 11.8, 11.8 vs 10.7, 10.7 g/dL, respectively). Hematocrit followed a similar trend (45.7, 46.1, 46.1 vs 43.0, 43.4 %; $P < 0.05$). Also, pigs fed 50, 100, or 150 ppm added Fe had increased ($P < 0.05$) plasma Fe concentration compared with pigs fed 0 ppm (1.72, 1.75, 1.77 vs 1.40 mg/L, respectively). A linear increase ($P < 0.01$) in whole body Fe concentration (142, 152, 161, 164, and 171 ppm) and a quadratic increase ($P < 0.01$) in liver Fe concentration (34, 38, 85, 123, and 113 ppm) were noted due to increasing dietary Fe. These results suggest Fe contributed by feed ingredients does not have detrimental effects on growth performance but is not adequate to maintain indices of Fe status during this rapid growth phase.

Key Words: Iron, Nursery Pig, Growth Performance

188 Effects of supplementing weanling pig diets with organic and inorganic acids on growth performance and microbial shedding. M. C. Walsh*¹, D. M. Sholly¹, S. A. Trapp¹, R. B. Hinson¹, B. E. Hill¹, A. L. Sutton¹, J. S. Radcliffe¹, B. G. Harmon¹, J. W. Smith², and B. T. Richert¹, ¹Purdue University, ²Kemin Americas Inc.

This experiment utilized 180 weanling pigs to evaluate the use of an organic acid based blend (OA; fumaric, lactic, citric, propionic, benzoic acids) and an inorganic acid based blend (IA; phosphoric, fumaric, lactic, citric acids) in nursery pig diets. Pigs (avg.18.2 d of age) were assigned to one of five dietary treatments: 1) Basal diet, 2) Diet 1 + 50 ppm carbadox, 3) Diet 1 + 0.4% OA, 4) Diet 1 + 0.2% IA, 5) Diet 1 + 0.4% OA and 0.2% IA (OA/IA). Pigs were allotted based on genetics, sex, and initial BW. Individual BW and pen feed intake were recorded weekly during the 35-d trial. Treatments were fed throughout the trial in three phases: d 0-7, d 7-21, and d 21-35. Pigs were housed 6 pigs/pen (.28 m²/pig) with 6 pens/treatment. There were no differences ($P > .05$) in ADG among the dietary treatments at any time during the study. The ADFI (d 0-35) for pigs fed the OA/IA diet tended to be lower ($P < .10$) than the ADFI of pigs fed all other treatments. The G:F of pigs fed Diet 1 tended to be lower ($P < .10$) than the G:F of pigs fed the carbadox diet, with all acid treatments being intermediate. Fecal pH, *E. coli* counts and salmonella shedding were determined at d 6, 20, and 34. There was no effect of treatment on the presence of fecal salmonella ($P < .10$) at any sampling time. On d 6, pigs fed Diet 1 had lower *E. coli* counts than pigs fed any other treatment ($P < .05$). There were no differences among treatments in fecal *E. coli* at d 20. At d 34, the *E. coli* counts for pigs fed the carbadox ($P < .05$) diet and the negative control ($P < .10$) were higher than pigs fed the OA/IA diet. Fecal pH of pigs fed the OA/IA diet was higher than for pigs fed the OA diet or the IA diet at d 6 ($P < .05$). There were no differences among treatments for fecal pH at d 20 and 34. The growth performance of pigs fed the OA and IA diets were similar to each other and the carbadox-fed pigs. Adding the combination of 0.4% OA and 0.2% IA acids to the nursery pig diets reduced feed intake and pig growth rate.

Key Words: Pigs, Acids, Carbadox

189 Evaluation of organic and inorganic acids in various feeding programs as alternatives to antibiotic growth promoters for nursery pigs. M. C. Walsh*¹, D. M. Sholly¹, R. B. Hinson¹, A. L. Sutton¹, J. S. Radcliffe¹, B. G. Harmon¹, J. W. Smith², and B. T. Richert¹, ¹Purdue University, ²Kemin Americas, Inc.

This study utilized 300 weanling pigs to evaluate an organic acid based blend (OA; fumaric, lactic, citric, propionic, benzoic acids) and an inorganic acid based blend (IA; phosphoric, fumaric, lactic, citric acids) in nursery pig diets. Pigs (avg. 17.7 d of age) were assigned to one of six dietary treatments: 1) Basal diet, 2) Diet 1 + 50 ppm carbadox, 3) Diet 1 + 0.4% OA, 4) Diet 1 + 0.2% IA, 5) Sequence 1; Diet 3 for 7 d followed by Diet 4 for 28 d, 6) Sequence 2; Diet 4 for 7 d followed by Diet 3 for 28 d. Pigs were allotted based on genetics, sex, and initial BW. Pen feed intake and individual BW were recorded weekly during the 35-d trial. Dietary treatments were fed throughout the trial in three phases: d 0-7, d 7-21, and d 21-35. Pigs were housed 10 pigs/pen (.22 m²/pig) and 5

pens/treatment. Feces were collected on d 32 (3 pigs/pen) for measurement of fecal pH, *E. coli* and salmonella. There was no effect ($P > .05$) of treatment on ADG, ADFI, or G:F during Phase 1. During Phase 2, ADFI of Sequence 1 was higher than Sequence 2 ($P < .05$) and tended to be higher than the OA diet ($P < .10$). Pigs fed carbadox tended ($P < .10$) to have greater ADFI than pigs fed OA and Sequence 2 diets. During Phase 3, ADG and ADFI for pigs fed Sequence 1 and carbadox were higher ($P < .05$) than all other treatments. Pigs fed Sequence 2 ($P < .05$) and carbadox ($P < .10$) diets had higher G:F than Diet 1 during Phase 3. Overall, pigs fed carbadox and Sequence 1 diets had the highest ADG (262, 294, 257, 257, 292, and 261 g/d, Diets 1-6, respectively; $P < .05$), higher ADFI than all other acid treatments ($P < .05$), and tended to have higher ADFI than Diet 1 ($P < .10$). Treatment had no effect on *E. coli* or salmonella shedding on d 32. Fecal pH of pigs fed Sequence 1 tended to be higher than the fecal pH of pigs fed Diet 1, Diet 4, and Sequence 2 ($P < .10$). Pigs fed Sequence 1 diets had similar growth performance to pigs fed carbadox and this novel dietary acid sequence may have merit as a replacement for antibiotics in the nursery phase.

Key Words: Pigs, Acids, Carbadox

190 Supplementation of inorganic acidifier on growth performance, nutrient digestibility, morphology of small intestine and immune response in weaning pigs. H. K. Oh, T. G. Go, C. S. Kong*, M. S. Yun, and Y. Y. Kim, *Seoul National University, Korea.*

This experiment was conducted to investigate effects of inorganic acidifier on growth performance, nutrient digestibility, blood urea nitrogen (BUN), gastrointestinal pH, morphology of small intestine and immune response in weaning pigs. A total of 120 pigs were allotted at 6.28 kg BW to 5 treatments in a randomized complete block design with 6 replicates. Treatments were: 1) Con (basal diet), 2) A0.1 (basal diet + 0.1% hydrochloric acid), 3) A0.2 (basal diet + 0.2% hydrochloric acid), 4) A0.3 (basal diet + 0.3% hydrochloric acid), 5) NA (antibiotic free basal diet + 0.2% hydrochloric acid) and scoria was used as a carrier. During the first 3 weeks, the highest ADG was in the A0.1 group ($P < 0.05$). Feed conversion ratio in all pigs fed diets containing hydrochloric acid was higher than that in pigs fed the control diet for 3 weeks after weaning. Crude protein digestibility in A0.1 group was increased 2.63% over that in Con group ($P = 0.12$); consequently protein retention was increased about 7 g/d in A0.1 compared to control. Blood urea nitrogen concentration in A0.1 group was maintained constantly at lower level than other treatments during experiment period. Especially, at the first week and second week, BUN concentration in A0.1 group was lowest among treatments ($P < 0.05$). Villi shape was not damaged by HCl-containing acidifier supplementation. The pH value in the stomach was decreased as inorganic acidifier level was increased ($P < 0.05$). Immunoglobulin A level in blood was lowered ($P < 0.05$) when pigs were fed diet containing hydrochloric acid compared to control diet during overall experimental period. Consequently, these results demonstrated that supplementation of a hydrochloric acid-containing acidifier resulted in increased nutrient utilization, particularly protein digestibility, and subsequently increased growth performance of weaning pigs for 3 weeks after weaning.

Key Words: Inorganic Acidifier, Growth Performance, Weaning Pigs

191 Effect of direct-fed microbials on growth performance of nursery pigs challenged orally with *Salmonella enterica* serovar typhimurium (ST). M. R. Barker*, S. S. Dritz, J. C. Nietfeld, and J. E. Minton, *Kansas State University.*

Direct-fed microbials may offer alternatives to antibiotics for nursery pigs. In the current study, we evaluated a product containing *Bacillus subtilis* and *Bacillus licheniformis* (BioPlus 2B; BP2B) and a yeast product (Levucell SB; LSB) in nursery pigs challenged with ST. Weaned pigs (n=85; initially 5.85 kg and 15 ± 1 d of age) were used in 2, 28-d trials to determine the effects of dietary additives on growth performance and fecal salmonellae. Pigs were fed 1 of 5 dietary treatments: 1) a negative control containing no direct-fed microbials or antibiotics (C); 2) a positive control with carbadox (CARB, 50 g/ton); 3) the control with BP2B, 454 g/ton; 4) the control with LSB, 100 g/ton; 5) the control with both BP2B [454 g/ton] and LSB [100 g/ton] (BP2B+LSB) for 14 d. All pigs were then challenged orally with 10⁶ ST prior to the final 14 d of the study. Pigs were housed 2/pen with 3 to 4 pens/treatment in

Trial 1 and 4 to 5 pens/treatment in Trial 2. There were trial and diet x trial effects ($P < .05$) for gain and feed intake that precluded combining the data from the 2 trials. In Trial 1, pigs fed the C and BP2B diets had greater gains and feed intakes ($P < .05$) than those fed CARB. In Trial 2, pigs fed CARB had greater gains and feed intakes than C, similar to other previous trials. CARB-fed pigs also had greater gains and feed intakes than BP2B+LSB ($P < .05$), whereas pigs fed BP2B and LSB had intermediate gains and feed intakes. Pigs fed BP2B ($P < .09$) and LSB ($P = .12$) averaged 109.8% greater daily gain over the entire 28 d in Trial 2 compared to pigs fed the C diet. Feed efficiency and fecal shedding were not affected by treatment. Although BP2B and LSB did not significantly improve gain, the trends observed when CARB improved gain relative to C in Trial 2 suggest that further investigation of BP2B and LSB is warranted.

Key Words: Nursery Pig, Direct-Fed Microbials, Salmonella

192 Growth and carcass characteristics of growing-finishing pigs fed either an antibiotic or a probiotic. L. M. Burnham*, C. R. Richardson¹, A. Guye¹, G. A. Nunnery¹, R. A. M. Schmitt², and S. W. Kim¹, ¹Texas Tech University, ²Seaboard Farms, Inc.

A total of 144 growing-finishing pigs (initial age, 89 ± 0.95 d and initial BW, 28 ± 0.35 kg) were used to test a hypothesis that probiotics were as effective as antibiotics as growth-promotants. The pigs were fed either a basal (control) diet, the basal diet with either 0.025 % antibiotic (tylosin) or 0.5 % probiotic (MSE) replacing an equal amount of corn during three phases, grower (42 d), finisher I (58 d) and finisher II (17 d), until they reached 121 ± 1.37 kg. Body weight and feed intake were measured at the end of each phase. Multiple Stabilized Enzymes (MSE) contains *Lactobacillus acidophilus*, *Bifidobacteria sp.*, yeast, fungal extract, and several enzymes. The basal diets contained 18.2, 15.5, and 14.7% CP and 3.36, 3.37, and 3.38 Mcal/kg ME for the grower, finisher I and finisher II phases, respectively. Pigs fed diets with the antibiotic tended to grow faster (0.74 vs. 0.65, $P < 0.09$) and more efficiently (0.43 vs. 0.41, $P < 0.09$) than the pigs fed the control diet during the grower phase but this effect disappeared in later phases. However, when the entire period was considered, there were no differences in ADG, ADFI and G/F between the control and the antibiotic groups. Pigs fed diets with the probiotic tended to grow more efficiently (0.34 vs. 0.33, $P < 0.08$) than pigs receiving the antibiotic during finisher I whereas they grew significantly faster (0.90 vs. 0.73, $P < 0.02$) and more efficiently (0.30 vs. 0.25, $P < 0.03$) than the antibiotic group during finisher II. However, there were no differences in ADG, ADFI and G/F between the probiotic and the antibiotic groups when the entire period was considered. When pigs reached 120 kg, they were transported to a regional processing facility to have carcass characteristics measured. Hot carcass weight, dressing percent, backfat thickness, loin depth, and percent lean of the probiotic group were not different from either the control or the antibiotic groups. This experiment demonstrates that probiotics can successfully replace, and possibly surpass performance supported by antibiotics.

Item	Treatments			SEM	P-values	
	Control (A)	Anti-biotic (B)	Pro-biotic (C)		A x B	B X C
ADG, kg						
Grower	0.65	0.74	0.72	0.03	0.09	0.73
Finisher I	0.90	0.84	0.88	0.03	0.28	0.47
Finisher II	0.73	0.73	0.90	0.05	0.98	0.02
Overall	0.77	0.79	0.83	0.03	0.74	0.29
Gain/Feed						
Grower	0.41	0.43	0.43	0.01	0.09	0.87
Finisher I	0.34	0.33	0.34	0.01	0.16	0.08
Finisher II	0.25	0.25	0.30	0.01	0.85	0.03
Overall	0.35	0.34	0.35	0.01	0.32	0.16

Key Words: Pigs, Probiotic, Antibiotic

193 Growth performance and carcass characteristics of growing finishing pigs fed diets containing peanut hulls, with or without added probiotic. L. L. Burnham^{*1}, C. R. Richardson¹, A. Guye¹, G. A. Nunnery¹, R. A. M. Schmitt², and S. W. Kim¹, ¹Texas Tech University, ²Seaboard Farms, Inc.

Two experiments were conducted to investigate whether the growth of pigs fed a diet containing peanut hulls was improved by the addition of a probiotic. Experiment 1 was conducted to identify the highest level of peanut hulls that would not impair feed efficiency when compared to the control. The various levels of peanut hulls (0, 5, 10, 15, 20 and 25%) were achieved by simple dilution of the basal (control) diet. The highest level of peanut hull inclusion that elicited feed efficiency similar to the control was 5% for grower and 10% for finisher I and II phases. In Experiment 2, 192 pigs (89 d, 28 kg BW) were fed peanut hulls with or without probiotic supplementation (.05% of Multiple Stabilized Enzymes, MSE, which contains *Lactobacillus acidophilus*, *Bifidobacteria sp.*, yeast, fungal extract and several enzymes) representing four treatments: A) control, B) control + MSE, C) fiber, and D) fiber + MSE. Pigs fed Diet D treatment gained 19% faster (.76 vs. .64 kg, $P < .03$) than the pigs fed the control diet during the grower phase but this improvement disappeared when the level of peanut hulls was increased from 5 to 10% during finisher I. Pigs fed Diet B gained significantly faster than the control (.74 vs. .89 for diets A and B, respectively, $P < 0.05$) during finisher II and there was a trend for improved G/F when compared to the control during the grower and finisher II phases (.40 vs. .44, $P < 0.06$; .26 vs. .30, $P < .06$, for diets A and B during the grower and finisher II phases, respectively). After the pigs attained 121 kg, they were slaughtered and carcasses measured for hot carcass weight, dressing percent, backfat, loin depth and percent lean. No significant differences were found among the four treatments. Although the overall performance of pigs fed diet that contained peanut hulls was not enhanced by the addition of the probiotic, there was a clear indication that probiotics may act synergistically with low levels of fiber.

Key Words: Pigs, Probiotics, Fiber

194 Fecal microflora change in pigs fed diets supplemented with inulin, sugar beet pulp or antibiotics. G. He^{*}, S. K. Baidoo, and Q. M. Yang, University of Minnesota.

The effect of dietary treatments on microbial population composition in the fecal samples of pigs were studied with colony counting techniques during two periods: 10 to 20 kg (Period 1) and 20 to 50 kg BW (Period 2). Multivariate analysis of direct fecal sample GLC of bacterial cellular fatty acids profile was performed for Period 1. The profile represents all bacterial cellular fatty acids in a sample and thus reflects the microflora change between sample groups. There were four dietary treatments: corn soybean meal control diet (CON); CON supplemented with inulin in drinking water (INU); CON supplemented with ground sugar beet pulp (SBP); or CON supplemented with antibiotics during Period 1 and without antibiotics during Period 2 (AB). Six animals per treatment were randomly selected and colony counts of bacteria were performed. Fecal samples from 14 pigs per treatment were used for bacterial cellular fatty acids analysis. For Period 1, lower total aerobes, total anaerobes and bifidobacteria were observed in AB group compared to other groups ($P < 0.01$). Differences in bacterial cellular fatty acids profiles were detected by likelihood ratio test ($P < 0.01$) and subsequent Bonferroni Hotelling T test indicated that except for CON versus AB, there were differences among treatment groups ($P < 0.01$). For period 2, INU and AB had higher total aerobes than CON and SBP ($P < 0.01$). SBP and AB had higher counts of lactobacilli than CON, and SBP had higher counts of lactobacilli than INU ($P < 0.01$). Higher counts of total anaerobes were observed in AB than CON or SBP ($P = 0.01$). In conclusion, fecal bacterial population was changed by dietary treatments. Withdrawal of antibiotics caused an increase in most of the bacterial groups studied. Multivariate analysis of bacterial cellular fatty acids profile is an alternative method to monitor bacterial composition change in swine feces.

Key Words: Pigs, Fecal Bacterial Population, Bacterial Cellular Fatty Acids

195 Effect of soluble and insoluble non-starch polysaccharides (NSP) on digesta passage rate and voluntary feed intake in grower pigs. A. Owusu-Asiedu^{*1}, R. T. Zijlstra¹, J. F. Patience¹, B. Laarveld², and H. Simmins³, ¹Prairie Swine Centre Inc., ²University of Saskatchewan, ³Danisco Animal Nutrition.

Soluble (SOL) and insoluble (INSOL) NSP may reduce digesta passage rate and voluntary feed intake. Effects of purified (SOL, guar gum; INSOL, cellulose) NSP on digesta passage rate and feed intake were studied with a 2 x 2 factorial treatment arrangement in 2 experiments. In Exp. 1, 12 pigs (27.0 ± 1.5 kg BW) fitted with an ileal T-cannula were used in a two-period change-over design, providing 3 pigs/diet/period. Each period was 18 d: 12-d acclimation, 2-d fecal, 3-d digesta and 1-d venous blood sampling. Diets were: 1) 14% cornstarch (CS), 2) 7% SOL NSP, 3) 7% INSOL NSP, and 4) 7% SOL + 7% INSOL NSP. NSP replaced CS 1:1. Pigs were fed 3 x maintenance based on CS diet. Compared to CS, SOL, INSOL and SOL*INSOL slowed digesta passage rate based on reduced ileal chromic oxide excretion rate ($P < 0.02$; 0.864, 0.570, 0.586, and 0.519 %/h, respectively), and increased time for initial appearance of chromic oxide in feces ($P < 0.01$; 24.5, 28.0, 24.6, and 27.0 h, respectively). Compared to CS, SOL and INSOL increased digesta viscosity ($P < 0.02$; 1.52, 5.57 and 6.35 cPs, respectively), indicating that both purified SOL and INSOL NSP are not inert in the gut. Plasma glucose was reduced by INSOL, compared to CS and SOL prior to morning feeding ($P < 0.01$; 88, 100 and 100 mg/dL, respectively), but not 1 h after feeding ($P > 0.10$). In Exp. 2, 20 pigs (26.0 ± 1.0 kg BW; individually-housed; 5 pigs/diet) had free access to the four diets for 14 d. Compared to CS, NSP reduced voluntary feed intake for d 0 to 14 (1683, 1426, 1382, and 1186 g/d, respectively), with the lowest feed intake for SOL*INSOL ($P < 0.05$). Both purified soluble and insoluble NSP slowed digesta passage rate and increased retention time in the total tract in grower pigs, resulting in reduced voluntary feed intake. Reducing negative effects of soluble and insoluble NSP may enhance feed intake and thereby nutrient intake.

Key Words: Pig, NSP, Passage Rate

196 Effect of soluble and insoluble non-starch polysaccharides (NSP) on ileal bacteria populations in grower pigs. A. Owusu-Asiedu^{*1}, R. T. Zijlstra¹, J. F. Patience¹, A. G. Van Kessel², and H. Simmins³, ¹Prairie Swine Centre Inc. ²University of Saskatchewan, ³Danisco Animal Nutrition.

Soluble (SOL) and insoluble (INSOL) NSP may influence gut bacteria populations, reflecting changes in fermentable material in the gut. Effects of purified (SOL, guar gum; INSOL, cellulose) NSP fractions on ileal bacteria populations and energy digestibility were studied. Twelve pigs (27.0 ± 1.5 kg BW) surgically fitted with an ileal T-cannula and housed in metabolism pens were used in a two-period change-over design, providing 3 pig/diet/period. Diets were: 1), 14% cornstarch as a purified carbohydrate source (CS), 2), 7% SOL NSP; 3), 7% INSOL NSP; and 4), 7% SOL+7% INSOL NSP; NSP replaced CS 1:1 [data are organized CS, SOL, INSOL, SOL+INSOL]. Pigs were fed 3 x maintenance based on CS diet. Diets were fed for 13 d, ileal digesta was collected under N, and bacteria were enumerated (\log_{10} cfu/g wet digesta) by culture on selective media. Bacterial populations were; total anaerobes (7.87, 8.12, 8.00 and 9.02), total aerobes (7.69, 8.16, 7.74 and 8.91), Bifidobacteria (7.04, 7.89, 7.12 and 7.70), Lactobacilli (7.58, 8.07, 7.43 and 8.68), Clostridia, (6.75, 7.39, 6.43 and 7.89), Enterococci (7.39, 7.55, 7.57 and 8.63) and Enterobacteria (7.12, 7.13, 7.46 and 8.61) for CS, SOL, INSOL and SOL+INSOL, respectively. Overall, NSP increased bacteria counts ($P < 0.05$), except for Bifidobacteria ($P > 0.10$). Lactobacilli, Bifidobacteria, Clostridia, Enterococci and Enterobacteria counts were highest for pigs fed SOL+INSOL ($P < 0.05$). Compared to CS, SOL, INSOL and SOL+INSOL reduced ileal ($P < 0.05$; 73, 64, 52 and 39%) and total-tract digestibility ($P < 0.0001$; 88, 87, 85 and 78%) of energy, reflecting the replacement of starch by NSP. Digesta DM in the ileum increased with increasing NSP ($P < 0.05$; 333, 457, 592 and 749 g/d). Increasing dietary purified soluble and insoluble NSP will increase the amount of fermentable dry matter in the small intestine, thereby providing further substrate for ileal bacteria proliferation in grower pigs.

Key Words: Pig, NSP, Ileal Bacteria Population

197 Growth and carcass traits of finishing pigs fed Paylean® were not compromised by diet formulations based on phytase. C. E. Pardo*, J. A. Kane, M. E. Glenn, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin.*

Improved performance traits of finishing pigs fed ractopamine (Paylean®, Elanco Animal Health) are well established, but concerns have arisen over the combined use of Paylean and phytase in diets formulated with no supplemental inorganic P (iP). This experiment was designed to evaluate the combination of Paylean and phytase (Natuphos®, 9400 G-concentrate, BASF) in diets for finishing pigs and to determine if additional iP was required. One hundred twenty crossbred (D x LW x LR) pigs were initially (50.5 ± 0.4 kg) fed diets with phytase (0 or 500 FTU/kg) for 4 wks. At 4 wks, pigs (82 ± 0.97 kg) were fed 1 of 5 diets for an additional 4 wk. Diets provided Paylean (0 vs 10 mg/kg, diets 1,2 vs 3,4,5), phytase (0 vs 500 FTU/kg, diets 1,3,5 vs 2,4) and iP (0.45 vs 0.65% total P, diets 1,3 vs 5). In diets with Paylean, total lysine levels were increased from 0.70% to 0.90%. As expected, ADG, feed efficiency, and carcass traits improved (P<0.05) with inclusion of Paylean in the diets. In pigs fed Paylean performance traits were not improved regardless of P level or source. However, pigs fed diets with Paylean and phytase tended (P < 0.15) to gain less than pigs fed diets with minimal P from iP. In conclusion, growth, feed efficiency and carcass traits of finishing pigs fed Paylean can be maintained with minimal supplemental P levels from either iP or phytase sources. An assessment of bone mineralization and skeletal integrity may alter inferences about needs for supplemental P.

Dietary Treatments

Item	1	2	3	4	5	SEM
Paylean®, mg/kg	0	0	10	10	10	
Phytase, FTU/kg	0	500	0	500	0	
P equivalents, %	0.45	0.45	0.45	0.45	0.65	
ADG, kg/d 28 to 56 d ^{a,b,c}	1.10	1.14	1.30	1.24	1.26	0.03
Feed/gain 28 to 56 d ^{b,c}	2.86	2.80	2.39	2.47	2.48	0.05
Hot Carcass Wt., kg ^{a,c}	88.7	89.1	90.7	92.7	93.3	1.33
Back Fat, mm ^{a,c}	21.0	22.3	19.3	18.8	20.1	1.02
Loin Eye Area, mm ² ^{a,b,c}	36.8	37.7	43.1	41.8	42.6	1.07

^a Blk, P<0.05. ^b Trt, P<0.05. ^c 1,2 v 3,4,5, P<0.05.

Key Words: Swine, Ractopamine, Phosphorus

198 Effect of dietary L-carnitine and ractopamine-HCl (Paylean®) on the metabolic response to handling in grow-finish pigs. B. W. James*¹, M. D. Tokach¹, R. D. Goodband¹, J. L. Nelsens¹, S. S. Dritz¹, J. M. DeRouchey¹, and J. C. Woodworth², ¹*Kansas State University*, ²*Lonza, Inc.*

Two experiments (384 pigs) were conducted to determine the interactive effect of dietary L-carnitine and ractopamine-HCl (RAC) on the metabolic response to handling. Experiments were arranged as split plots with handling as main plot and diet as sub plots (4 pens/trt). Carnitine (0 or 50 ppm) was fed from 38.5 kg to the end of the trials (120 kg) and RAC (0 or 20 ppm) was fed for the last 4 wk of each trial. At the end of each trial, two pigs per pen were assigned to each handling treatment. Gentle-handled pigs were moved at a moderate pace through a 150 m course with a 15deg loading ramp. Non-gentle handled pigs were moved at a faster pace, up a 30deg ramp, and were subjected to an electrical prod. Blood was collected immediately before and after handling in Exp. 1 and immediately after and 1 h after handling in Exp. 2. Feeding RAC increased (P<0.01) ADG and gain/feed. In Exp. 1 and 2, non-gentle handling increased (P<0.01) lactate dehydrogenase (LDH), lactate, cortisol, and rectal temperature, and decreased blood pH. In Exp. 1, a RAC x handling interaction (P<0.06) was observed for pH and temperature. Non-gentle handled pigs fed RAC had decreased pH and increased temperature and tended (P<0.09) to have higher lactate. Pigs fed RAC had increased LDH compared to pigs not fed RAC. Pigs fed carnitine had increased (P<0.03) lactate compared to pigs not fed carnitine. In Exp. 2, pigs fed RAC had lower (P<0.02) pH immediately after handling but pH returned to control levels (P>0.96) by 1 h post-handling. Lactate, LDH, cortisol, and temperature changes from immediately post-handling to 1 h post-handling were not different for pigs fed carnitine or RAC suggesting carnitine did not decrease recovery time of pigs subjected to non-gentle handling. These results suggest that pigs fed RAC are more susceptible to stress when handled aggressively

compared to pigs not fed RAC. Carnitine did not alleviate the effects of stress when fed in combination with RAC.

Key Words: Carnitine, Ractopamine, Pigs

199 Interactive effects between ractopamine HCl (Paylean(r)) and pantothenic acid in grow-finish pigs. C. N. Groesbeck*, R. D. Goodband, M. D. Tokach, J. L. Nelsens, S. S. Dritz, J. M. DeRouchey, B. W. James, T. P. Keegan, C. W. Hastad, K. R. Lawrence, N. A. Lenehan, and N. Z. Frantz, *Kansas State University.*

An experiment using 156 pigs (PIC, initial BW = 25.7 kg) was conducted to evaluate the interactive effects of ractopamine HCl (RAC; 0 or 10 ppm) and added pantothenic acid (PA; 0, 22.5, or 45 ppm) on growth performance and carcass composition. Pigs were blocked by weight and sex, and randomly allotted to one of six dietary treatments. There were two pigs per pen and 13 pens per treatment. The study was arranged as a factorial with main effects of PA and RAC. Pigs were fed the assigned PA levels from 25.7 kg to market (d 0 to 98) and RAC for 28 days prior to harvest at a commercial facility. Pigs were weighed and feed intake was determined every 14 d. Increasing added PA had no effect (P > 0.05) on ADG, ADFI, or feed efficiency (G/F) from d 0 to d 70. A PA gender interaction (P < 0.03) was observed for ADG and G/F from d 70 to 98. Increasing PA increased ADG (.93, 1.01, and 1.05 kg) and G/F (0.34, .36, and 0.38) in gilts, but there were no differences for ADG (1.09, 1.02, and 1.02 kg) and G/F (0.35, 0.35, and 0.34) in barrows. From d 0 to 98, G/F increased (P < 0.02) with increasing added PA (0.38, 0.40, and 0.41) in gilts, and no differences in barrows (0.39, 0.40, and 0.39). Added RAC increased (P < 0.001) ADG (1.11 vs 0.93 kg) and improved G/F (0.38 vs 0.33) for the last 28 d prior to market and for the overall trial. Increasing added PA had no effect (P > 0.05) on carcass composition. Adding RAC increased (P < 0.0001) longissimus area and percentage lean and decreased (P < 0.02) tenth rib fat depth. These results suggest that RAC improves growth performance and carcass lean, but has no interactive effects with added PA. Added PA increased ADG and G/F in gilts, but not in barrows.

Key Words: Pantothenic Acid, Ractopamine, Pigs

200 Effect of conjugated linoleic acid (CLA) on growth performance, backfat thickness and loin muscle area in pigs sorted based on initial leanness. M. Azain*, *University of Georgia.*

There has been considerable interest in the use of CLA as a repartitioning agent in swine. While the effects of dietary CLA have been consistent in rodent studies, they have been less reproducible in other species. A survey of published studies in pigs suggests that the variation in response may at least partially be explained by differences in the total amount of dietary fat and by differences in leanness of the pigs used. To test the latter, growing, individually-penned barrows were sorted into high (2.3 cm) and low (1.7 cm) tenth rib fat thickness groups using real time ultrasound at approximately 65 kg body weight. Within each group, pigs were assigned to either control or CLA dietary treatments. Pigs were fed a corn-soy diet with 15% CP and 0.85% lysine that was supplemented with either 1% soy oil (Control) or CLA (CLA-60) for 7 weeks. Body weight, feed intake and ultrasound measures of fat thickness and loin area at the tenth rib were determined weekly. There were no differences in final body weight (112 kg), gain (0.96 kg/d), or intake (2.49 kg/d) due to diet or initial leanness. Gain:Feed ratio was lower in high fat pigs compared to the low fat (0.38 vs 0.40, P < 0.01), but was not affected by CLA. Pigs that were fatter initially remained so during the study (High 2.68 vs Low 2.18 cm, P < 0.01). There was a numerical reduction in fat accretion in fat pigs fed CLA (High-Control, 0.37 vs High CLA, 0.20 cm, P < 0.20) and no effect of CLA on the low fat group. Calculated percent lean was greater in the low fat pigs (50.6 vs 48.5, P < 0.02) and numerically greater in CLA fed pigs (50.2 vs 49.0, P < 0.20). Overall, there were minimal effects of CLA on performance and carcass composition as determined by ultrasound. However, the greater reduction in fat accretion seen in pigs with high fat thickness is supportive of an interaction in the response to CLA with body composition.

Key Words: Ultrasound, Pigs, CLA

201 Evaluation of an optimum fat level for late nursery pigs. B. W. Ratliff¹, A. M. Gaines¹, P. Srichana¹, G. L. Allee¹, and J. L. Usry², ¹University of Missouri, ²Ajinomoto Heartland LLC.

Three experiments were conducted at a commercial research site to evaluate the optimum fat level for late nursery pigs. In Exp. 1, a total of 739 pigs (TR-4 C22; 17.6 ± 0.21 kg) were used in a completely randomized block design with 7 replicate pens/treatment (20-22 pigs/pen). In Exp. 2, a total of 757 pigs (TR-4 C22; 13.1 ± 0.15 kg) were used in a completely randomized block design with 7 replicate pens/treatment (20-22 pigs/pen). Pigs used in Exp. 1 and 2 were allotted to one of five dietary treatments containing 0.0, 1.5, 3.0, 4.5 and 6.0% supplemental fat, respectively. Diets were formulated at a lysine:calorie ratio of 3.59 g true ileal digestible lysine/Mcal ME. In Exp. 3, a total of 1,700 pigs (TR-4 C22; 17.1 ± 0.16 kg) were used in a 2 × 5 factorial design with 8 replicate pens/treatment (20-22 pigs/pen). The main effects were lysine:calorie ratio (3.33 and 3.86 g true ileal digestible lysine/Mcal ME) and supplemental fat level (0.00, 1.5, 3.0, 4.5, and 6.0%). In Exp. 1, fat supplementation increased (linear, P < 0.02) ADG (739, 739, 753, 767, and 762 g/d), decreased (linear, P < 0.01) ADFI (1261, 1225, 1188, 1207 and 1188 g/d) and improved (linear, P < 0.001) G/F (0.588, 0.604, 0.636, 0.638, and 0.643). For Exp. 2, fat supplementation increased (linear, P = 0.03) ADG (612, 617, 635, 631, and 653 g/d) and improved (linear, P < 0.001) G/F (0.651, 0.674, 0.687, 0.700, and 0.711). In Exp. 3, there were no effect of lysine:calorie ratio (P > 0.30), or lysine:calorie ratio × fat level interactions (P > 0.49). However, fat supplementation increased (linear, P < 0.001) ADG (685, 699, 694, 703, and 721 g/d) and improved (linear, P < 0.001) G/F (0.619, 0.640, 0.635, 0.652, and 0.666). These data indicate that increasing the energy density of late nursery pig diets results in linear improvements in growth performance. Based on linear regression analysis, for each one percentage unit increase in supplemental fat addition there are 0.81% and 1.42% improvements in ADG (r² = 0.99) and G/F (r² = 0.98), respectively.

Key Words: Pigs, Fat, Energy

202 Growth, body composition and nutrient deposition rates in weaned pigs fed diets with similar digestible but different estimated net energy content. T. F. Oresanya^{1,2}, A. D. Beaulieu¹, and J. F. Patience¹, ¹Prairie Swine Centre Inc., ²University of Saskatchewan.

Net energy (NE) has theoretical advantages over DE and ME, accounting for metabolic utilization and partitioning of energy in body tissue. Empirical results supporting these benefits in practice are lacking. This experiment examined the growth, body composition and nutrient deposition in weaned pigs fed diets with similar DE but increasing NE content. A total of 256 weaned pigs (20 ± 1 d; 6.8 ± 1 kg; mean ± SD) were blocked by sex and randomly allocated to pens of 4 pigs each (12 pens/trt) or an initial slaughter group (n=16; ISG). Diets with similar CP content (26.7%) but increasing fat (HiCP1, HiCP2, HiCP3) or declining CP but similar fat (MedCP, 23.1%; LoCP, 19.9%) were formulated to a similar DE (3.53 Mcal/kg) and lysine/DE content and ideal protein ratios. NE content increased from 2.24 to 2.40 Mcal/kg. At the end of 28 d growth period, 12 pigs/trt were sacrificed for carcass analysis. Empty body (EB) protein and lipid content and respective deposition rates (PD and LD) were determined. ADG was similar for HiCP1 and MedCP, and was lowest for HiCP3 (P < 0.005); LoCP and HiCP2 yielded intermediate results. FCR was similar across trt (P > 0.05). Carcass and EB protein content, and PD were similar for HiCP1, HiCP2 and MedCP but depressed in LoCP and HiCP3 (P < 0.05). EB lipid content was highest on the LoCP diet, and similar for all other trts (P < 0.05). Regression analysis revealed a breakpoint for ADG and PD at DEi = 3.14 and 3.18, and NEi = 2.02 and 2.03 Mcal/d, respectively (P < 0.001; R², 0.50). The breakpoint for LD occurred at higher energy intakes (DEi=3.35; NEi=2.09 Mcal/d). Contrary to widely held assumptions, these weaned pigs were able to consume sufficient energy to exceed PDmax, as additional energy was utilized for increased LD. The performance of weaned pigs was not accurately predicted by DE, but NE offered no improvement. Our knowledge of energy metabolism in the weaned pig clearly requires detailed review.

Key Words: Piglets, Digestible Energy, Net Energy

203 Effects of corn source and added fat level on performance of grow-finish pigs reared in a commercial facility. C. W. Hastad¹, M. D. Tokach¹, J. L. Nelssen¹, S. S. Dritz¹, R. D. Goodband¹, J. M. DeRouche¹, C. L. Jones¹, and C. M. Peter², ¹Kansas State University, ²BASF Corp.

A total of 1,144 gilts (initially 50.1 kg) were used in a commercial research facility to evaluate the effects of corn source (NutriDense(tm), BASF or #2 Yellow Dent) and added fat (averaging 0, 3, and 6%) on pig performance and carcass traits. Energy levels were based such that the higher energy (5% greater ME than #2 yellow dent assumed) in NutriDense (ND) corn (with or without added fat) was calculated to be equal to that provided by yellow dent corn and added fat. In each phase, the first treatment diet contained yellow dent corn and no added fat, in the next dietary treatment, yellow dent corn was replaced with ND corn and then fat was added (2.7 to 3.2% based on phase) to the yellow dent corn diet to equal the energy content of the ND corn diet. This amount of added fat was then added to the ND-based diet. The last yellow dent corn-based diet used 5.2 to 6.2% (based on phase) added fat to equal the energy content of the second ND corn diet. This amount of fat was then added to the ND corn diet to complete the 2x3 factorial. For the overall study, pigs fed ND corn had greater (P < 0.04) ADG compared to pigs fed yellow dent corn. There was a corn source by fat level interaction (P < 0.01) for ADFI and feed efficiency (G/F). When fat was added to diets containing ND corn, F/G decreased linearly, whereas when fat was added to yellow dent corn the greatest improvement in feed efficiency was observed by adding the first 3% fat. Adding fat to diets also increased (P < 0.01) final BW and carcass weight, and tended (P < 0.09) to increase backfat thickness. Using the known energy values of yellow dent corn and fat, we calculated ND corn to have 5.3% more ME than yellow dent corn. These results are similar to our previous research in nursery pigs indicating ND corn has 5% more ME than yellow dent corn. In this commercial facility, ADG and G/F improved linearly as energy increased in the diet whether the energy was from a higher energy corn source or added fat.

Key Words: Corn, Fat, Pigs

204 Determination of the metabolizable energy concentration of corn samples for growing pigs. J. D. Schneider*, S. D. Carter, J. S. Park, and T. B. Morillo, Oklahoma State University.

An experiment using 100 barrows (avg BW = 26.1 kg) was conducted to determine the ME concentration of 10 corn samples. Pigs were housed individually in metabolic chambers and allotted randomly to 10 dietary treatments (10 pigs/trt) based on BW. Experimental diets (n = 10) were formulated to 1.0% total lysine and consisted of corn (90.48%), casein (5.04%), crystalline amino acids, and vitamin/mineral sources. The corn samples were ground to a common particle size prior to mixing the diets. Pigs had ad libitum access to water and an effort was made to equalize feed intake within replicate. Following a 7-d adjustment period to the diets, a 5-d total collection of feces and urine was performed. Data are reported on a DM basis. The GE of the corn samples averaged 4,359 kcal/kg (range of 4,322 to 4,436). The CP content averaged 8.44% (range 7.68 to 9.05). Daily GE intake averaged 5,852 ± 315 kcal and was not affected (P > 0.10) by dietary treatment. Fecal GE excretion (kcal/d) differed (P < 0.05) among treatments, but urine GE excretion (kcal/d) was similar (P > 0.05). The DE of the ten diets averaged 3,889 ± 22 kcal/kg (range 3,843 to 3,922), with differences (P < 0.10) noted among treatments. Similar to DE, ME (avg 3,853 ± 22 kcal/kg) of the ten diets varied (P < 0.10) among treatments. DE:GE and ME:GE (0.896 and 0.888, respectively) also varied (P < 0.10) among treatments. Subtraction of the ME provided by casein (230 kcal/kg) from the ME of the diets resulted in an average ME concentration for the ten corns of 4,004 ± 24 kcal/kg (3,573 ± 22 kcal/kg as-fed). There were numerous differences (P < 0.10) among corns in DE and ME content, and DE:GE and ME:GE ratios for the ten samples. Based on these results, the initial gross energy concentration of corn is not an accurate indicator of the metabolizable energy concentration due to the variation in ME:GE ratio.

Key Words: Pigs, Energy, Corn

205 Effect of added fat, carnitine, and lysine to calorie ratio on grower pig performance. R. B. Hinson¹, L. M. Wilson*¹, S. A. Trapp¹, J. S. Radcliffe¹, K. Q. Owen², J. C. Woodworth², and B. T. Richert¹, ¹Purdue University, ²Lonza Inc.

The effects of increased dietary energy, carnitine, and lysine:calorie (Lys:Cal) were evaluated using 427 terminally crossed pigs blocked by BW (avg. 23.6 kg) and randomly assigned to dietary treatments. Ten dietary treatments were used containing: 0, 3.5, or 7% added fat; 0 or 50 ppm supplemental L-carnitine; with or without maintaining the Lys:Cal in the 3.5 and 7.0% fat diets. Pigs were housed in 60 pens (6 pens/trt) in two barns. The trial consisted of two 21 d phases, with treatments maintained in all phases. Individual BW and pen feed intake were recorded on d 0, 21, and 42. Ultrasonic estimates (4 pigs/pen) of 10th (TRBF) and last rib backfats (LRBF) and loin eye area (LEA) were determined on d 0, 20, and 41. No main effects of carnitine on any growth response criteria were observed ($P > .10$). ADG during Phase 1 (d 0-21) was unaffected by increasing dietary fat, but ADFI decreased linearly ($P < .001$) and G:F improved linearly ($P < .001$). During Phase 2 (d 21-42) and overall (d 0-42) ADG ($P < .05$) and G:F ($P < .001$) were linearly increased, ADFI ($P < .001$) was linearly decreased as dietary fat increased. Both LRBF ($P < .01$) and TRBF ($P < .05$) increased linearly as fat increased in the diet. Increasing Lys:Cal improved Phase 1 ADG (780 vs. 804 g/d; $P < 0.03$) and G:F (.563 vs .573; $P < .05$). An interaction ($P < .04$) was observed between carnitine and Lys:Cal on ADG, with ADG increasing when the Lys:Cal was increased in carnitine supplemented diets, but decreasing when Lys:Cal was increased in non-carnitine supplemented diets. A 3-way interaction ($P < .02$) between fat level, carnitine, and Lys:Cal on Phase 2 and overall ADG was observed. Increasing the Lys:Cal increased Phase 2 and overall ADG at all fat and carnitine levels, with the exception of 7% added fat and no added carnitine where an increase in Lys:Cal caused a decrease in ADG. Increasing dietary energy during the grower phase improved pig growth performance and maintaining the Lys:Cal further enhanced the growth response to increased fat.

Key Words: Pigs, Carnitine, Energy

206 Impact of high dietary oleic acid on growth performance and pork quality. E. O. Castaneda*^{1,2}, M. Ellis¹, F. K. McKeith¹, and D. Brana^{1,3}, ¹University of Illinois, ²CONACYT, Mexico, ³INIFAP, Mexico.

The objective of the study was to compare the effects of dietary inclusion of high oleic sunflower oil (HOSO) or soybean oil (SO) on growth and meat quality. The study was carried out for 35 days from 75 to 120 kg BW, using a completely randomized design with six dietary treatments: 1) Control (corn and soybean meal); 2) SO (5% of the diet); 3) HOSO (5%); 4) SO (10%); 5) HOSO (10%); and 6) 50:50 mixture of SO and HOSO (10%). A total of 144 pigs were housed in single-sex pens (barrows or gilts; 4 pigs/pen). At the end of the study two pigs per pen were randomly selected for slaughter. Treatment means were compared using preplanned contrasts. Compared to controls, pigs fed 5 or 10% added fat ate less ($P < 0.05$; 3.27, 2.97, and 2.91 kg/d; SEM= 0.075), had better gain:feed ratio ($P < 0.05$; 0.36, 0.39, and 0.43; SEM= 0.008) and greater ($P < 0.05$) 10th rib BF thickness (2.07, 2.43, and 2.60 cm; SEM= 0.106). Ultimate pH was higher ($P < 0.05$; 5.54 vs. 5.49; SEM= 0.015), whereas L#42# value (53.70 vs. 55.90, SEM= 0.768), drip loss (4.40 vs. 5.35 %, SEM= 0.419), and shear force (4.16 vs. 4.56 kg, SEM= 0.178), were lower ($P < 0.05$) for the SO treatments when compared with the control. Intramuscular fat content was increased ($P < 0.05$; 2.07, 2.73, and 2.67%; SEM= 0.201) with 5 or 10% of fat inclusion in the diet when compared to control. Pork flavor (15 point scale) in the longissimus muscle was enhanced ($P < 0.05$; 7.88 vs. 7.34; SEM= 0.134) for the HOSO compared to the SO treatments. The percentage of oleic acid in backfat (51.8 vs. 34.7, SEM= 0.97) and in intramuscular fat (48.2 vs. 42.3, SEM= 1.23) was higher ($P > 0.05$) for HOSO compared to SO treatments, while SO increased ($P < 0.05$) the percentage of linoleic acid in the same tissues (25.2 vs. 10.7, SEM= 0.86; and 10.7 vs. 8.9, SEM= 0.79). In conclusion, fat sources with high oleic fatty acid content can be used in the finishing diet to increase pork flavor with no detrimental effect on growth performance, carcass characteristics, or meat quality.

Key Words: Pigs, Fat, Meat Quality

207 Effect of corn distiller's dried grains with solubles (DDGS) on growth, carcass characteristics and fecal volume in growing-finishing pigs. S. X. Fu*¹, M. Johnston², R. W. Fent¹, D. C. Kendall¹, J. L. Usry³, R. D. Boyd², and G. L. Allee¹, ¹University of Missouri, ²The Hanor Company, ³Ajinimoto Heartland LLC.

Two trials were conducted to determine the effect of dietary corn distiller's dried grains with solubles (Dakota Gold[®]; DDGS) on growth, carcass characteristics and fecal excretion in growing-finishing pigs. In Trial 1, 256 barrows with an initial BW of 28.5 kg were fed experimental diets in a 5-phase feeding program. Dietary treatments involved 0, 10, 20 and 30% DDGS, with 8 replicate pens of 8 pigs per pen. Experimental diets were formulated to contain equivalent apparent ileal digestible lysine (1.06, 0.89, 0.77, 0.70 and 0.63% respectively). Diets were isocaloric (1 to 2% added fat) and formulated using 0.15% (Phase 1 to 4) or 0.10% (Phase 5) L-Lysine HCl so that digestible threonine, tryptophan and sulfur amino acids were held equal or above the control. The addition of DDGS resulted in a linear decrease in feed intake (2.56, 2.53, 2.44 and 2.41 kg/d; $P < 0.001$), ADG (1.03, 1.01, 0.99 and 0.98 kg/d; $P < 0.001$) and body weight (123.8, 121.7, 121.2 and 118.9 kg; $P < 0.01$) after 92d on test. No difference was observed in G:F (0.405, 0.400, 0.407 and 0.405; $P > 0.45$) for the 92-d test period. However, gain:feed was improved in a linear ($P < 0.01$) manner for the first 42 d on test with increasing DDGS. Carcass weight was reduced linearly ($P < 0.002$) as dietary DDGS level increased. No differences in backfat, loin depth, percentage carcass lean and yield were observed among treatments. In Trial 2, 12 pigs (97.4 kg) were placed in metabolism crates allowing for separate and total collection of urine and feces in an environmentally controlled room. Pigs were allotted to treatments of 0, 10 or 20% DDGS in two periods of a 7d adaptation and 3d collection of urine and feces. Fecal mass increased linearly ($P < 0.06$) with increasing DDGS addition. Fecal volume increased 5.7% and 13.2% in pigs fed 10% and 20% DDGS diets, respectively. These results suggest that feeding DDGS for a fixed time period will reduce pig slaughter and carcass weight while increasing fecal volume.

Key Words: Distiller's Dried Grains with Solubles, Pigs, Fecal Volume

208 Energy value of dried distillers grains with solubles in swine diets. C. W. Hastad*, M. D. Tokach, J. L. Nelssen, R. D. Goodband, S. S. Dritz, J. M. DeRouchey, C. N. Groesbeck, K. R. Lawrence, N. A. Lenehan, and T. P. Keegan, Kansas State University.

Two experiments were conducted to determine the energy value of dried distillers grains with solubles (DDGS). In Exp.1, 360 pigs (initially 17.5 kg) were used in a 22 d growth assay. Treatments consisted of five corn-soybean meal-based diets with added wheat bran or soy oil to provide five ME levels ranging from 3,064 to 3,536 kcal/kg. Two sources of DDGS were used, one from a relatively new plant (MN), and a second from an older plant (NB). Pigs were fed four additional diets including either 15 or 30% DDGS from each source. For the 22 d growth trial, increasing energy increased (linear; $P < 0.01$) ADG and feed efficiency (G/F) and reduced (linear; $P < 0.01$) ADFI. The linear improvement in G/F allowed estimation of the kcal of ME/kg of DDGS for the MN (3,494) and NB (3,128) sources. In Exp. 2, eight barrows (initially 44.6 kg) were used in a metabolism study with treatments arranged in a Latin square design to determine the ME of the two DDGS sources used in Exp. 1. Diets were 97% DDGS with added amino acids, vitamins, and minerals to meet or exceed the pigs nutrient requirements. Estimated DE (3,871 vs. 3,728; $P < 0.02$) and ME (3,697 vs. 3,587; $P < 0.05$) were higher for the MN compared to the NB DDGS. These ME values were 6% higher for the MN DDGS and 15% higher for the NB DDGS than were calculated in our growth trial. Estimating net energy from chemical composition suggests that DDGS have a lower energy value relative to corn (96% and 90% for MN and NB, respectively). These studies suggest possible variation in the energy value of DDGS based on how it is measured. Measurement of ME through nutrient balance studies where pigs are individually fed a limited amount of feed appears to over estimate utilizable energy as compared to net energy calculations or the predicted value from growth trials.

Key Words: Distillers Dried Grains with Solubles, Pigs, Energy

209 Effect of basal diet formulation and wheat bran inclusion on growth performance and carcass characteristics of finishing pigs. D. M. Sholly*, M. C. Walsh, R. B. Hinson, K. L. Saddoris, L. M. Wilson, A. L. Yager, B. T. Richert, and A. L. Sutton, *Purdue University*.

Three hundred-thirty six pigs (initial BW = 67.5 kg) were used to determine the effects of basal diet formulation (BD) and wheat bran (WB) inclusion rate on growth performance and carcass characteristics. Pigs were blocked by BW, sex, and barn (7 mixed sex pigs/pen; 3 pens/treatment/barn) and randomly allotted to one of 8 diets arranged in a 2 X 4 factorial design with two basal diet formulations (standard corn-SBM meal diet; CTRL, and a reduced nutrient excretion diet; LNE) and 4 levels of WB (0, 5, 10, or 15%). The LNE diet contained low phytic acid corn, 300 U/kg phytase, synthetic amino acids balanced to NRC ratios, and added dietary fat to maintain ME/kg. Bi-weekly BWs and pen feed intakes were recorded and diets were fed in two phases, Finisher 1 (F1; d 0-27) and Finisher 2 (F2; d 27-55). ADG, ADFI, and G:F were unaffected by BD formulations, except during F2 when ADFI was lower for the LNE diet compared to the CTRL (P<0.05). As WB inclusion increased, F1 ADG and ADFI decreased linearly (P<0.01) and F1 and F2 G:F improved up to 5% and 10% inclusion, respectively, and then declined (quadratic; P<0.03). There was an interaction of BD and WB for F2 ADG (P<0.05), with ADG increasing up to 5% WB and then decreasing with further increases in WB. The magnitude of this response was more pronounced in the CTRL diets than in LNE diets. Overall, ADFI linearly decreased (P<0.02); ADG (779, 784, 777, 730 g/d, WB 0-15%, respectively), G:F (.311, .322, .323, .307, WB 0-15%, respectively), and final BW increased and then decreased as WB inclusion increased (quadratic; P<0.01). Last rib and 10th rib backfat (TRBF) linearly decreased as WB inclusion increased from 0 to 15% (P<0.02). The LNE formulation tended to increase ultrasound TRBF depths (P<0.06), carcass loin depth (P<0.08), and carcass yield (P<0.10) compared to the CTRL diets. Inclusions of WB up to 5% of the diet improved pig ADG and G:F, however, including 15% WB in finisher diets decreased growth performance.

Key Words: Pigs, Crude Protein, Wheat Bran

210 Influence of Carnichrome® on energy balance of gestating sows. M. G. Young*¹, M. D. Tokach¹, J. Noblet², F. X. Aherne³, S. S. Dritz¹, R. D. Goodband¹, J. L. Nelssen¹, J. van Milgen², and J. C. Woodworth⁴, ¹*Kansas State University*, ²*INRA, France*, ³*Alberta Pig Company*, ⁴*Lonza, Inc.*

Twelve multiparous sows with an average initial weight of 182 kg were utilized in a randomized complete block design to determine the effects of feeding Carnichrome® (r) (50 ppm carnitine and 200 ppb chromium picolinate/kg feed) on the energy and nitrogen utilization in early-, mid- and late-gestation. All sows were fed a diet either with or without Carnichrome® (r) for the 28 d lactation, the weaning-to-estrus period, and for the duration of gestation. Daily feeding allowances were based on calculated energy and nutrient requirements to achieve a target sow maternal weight gain of 20 kg and remained constant throughout gestation. The kinetics of heat production (HP) and its partitioning (activity HP) were determined in early- (wk 5 or 6), mid- (wk 9 or 10) and late- (wk 14 or 15) pregnancy using indirect calorimetry. Net maternal weight gain and total number of fetuses averaged 21.6 kg and 16.5, respectively. Organic matter and energy digestibility for the Carnichrome® (r) diet was greater (P < 0.05), which resulted in greater DE and ME contents (P < 0.05) compared with the control diet. Carnichrome® (r) had no effect on total HP, energy retained as protein or lipid and maternal energy retention in early-, mid- or late-gestation. There was no interaction between Carnichrome® (r) and stage of gestation. Increased energy requirements in late gestation led to a linear increase in HP (4.0 kJ/kg BW^{0.75}/d) from d-90 to 110. Energy requirements for maintenance averaged 405 kJ/kgBW^{0.75}/d. On average, activity HP was 116 kJ/kgBW^{0.75}/d, which was equivalent to 20% of ME intake, but ranged from 11 to 37%. This shows that physical activity represents a major factor causing differences in energy balance between sows. In conclusion, Carnichrome® (r) had no effect on the components of heat production and maternal weight gain during gestation, although it improved energy and organic matter digestibility of the diet.

Key Words: Sows, Carnichrome®, Gestation

211 Effect of feeding protected n-3 polyunsaturated fatty acids (Fertilium™) on litter size in gilts. J. D. Spencer*, L. Wilson, S. K. Webel, R. L. Moser, and D. M. Webel, *United Feeds, Inc.*

The number of pigs farrowed by gilts (PIC C-22) fed a diet containing protected n-3 polyunsaturated fatty acids (PFA, Fertilium™, United Feeds, Inc. Sheridan, IN) prior to first breeding was evaluated. A total of 317 gilts, in six replicate groups, were randomly assigned to one of two experimental treatments at approximately 180 d of age. Treatments consisted of either a control, corn-soybean meal based diet or the control diet containing 1.5% PFA at the expense of corn and soybean meal. Dietary treatments were provided ad libitum 30 d or more prior to breeding. Subsequent litter size is shown in the following table. The litter size was increased by 1 pig (P ≤ 0.01) at the subsequent farrowing for gilts fed PFA compared to controls. Additionally, individual piglet birth weights were collected from litters within one replicate (n = 21 litters/treatment). Associated with the increase in litter size, the average piglet BW was lower (1.42 vs 1.37 kg/pig; P<0.05) for the PFA supplemented group. However, the proportion of low birth weight piglets was similar between treatments (23 vs 24 %; P≥0.10 for control and PFA, respectively). These data demonstrate an increase in litter size when gilts are fed PFA 30 d or more prior to breeding, and yet do not reflect an increase in number of low birth weight piglets.

Effect of PFA fed to gilts for 30 d or more prior to first breeding

Response	Control	PFA
Total Born	11.0 ^a ± 0.22	12.1 ^b ± 0.27
Live Born	10.4 ^a ± 0.23	11.4 ^b ± 0.27

^{a,b} Means within row lacking common superscripts are significantly different (P<0.01).

Key Words: Polyunsaturated Fatty Acids, Litter Size, Gilts

212 Effect of feeding duration of protected n-3 polyunsaturated fatty acids (Fertilium™) on litter size and embryo survival in sows. S. K. Webel*, E. R. Otto-Tice, R. L. Moser, and D. E. Orr, Jr., *United Feeds, Inc.*

The effect of feeding duration of a protected n-3 polyunsaturated fatty acid source (PFA, Fertilium™, United Feeds, Inc. Sheridan, IN) on subsequent sow reproductive performance was evaluated. Primiparous and multiparous sows were randomly allotted by parity to a three treatment, randomized complete block design at two research farms. Sows were allotted to treatment at 102 d of gestation, weaned after 16 ± 1 d lactation, then mated at first estrus. Dietary treatments were 1) control, 2) PFA fed from entry into farrowing room until bred, and 3) PFA fed from 8 d prior to entry into farrowing room until bred. Corn-soybean meal based diets served as control treatment. All PFA treated sows received control diets supplemented with 85 g PFA daily. The results for subsequent reproductive performance are presented in the following table. The number of total and live born pigs was 0.7 pigs greater (P<0.05) at the subsequent farrowing for sows fed PFA during late gestation, lactation, and rebreeding compared to sows fed either control or PFA during lactation and rebreeding. Wean to estrus intervals and farrowing rates were not different (P≥0.10) between treatments. A second trial compared the effects of feeding PFA for the entire previous gestation, lactation, and subsequent rebreeding cycle on embryo survival. Sows (n=36) were sacrificed to determine CL and embryo numbers at 30 + 5 d post breeding. The number of CL for control and PFA treated sows were 20.1 and 20.3, respectively (P=0.85). Live embryos for control and treated sows were 11.9 and 14.5, respectively (P=0.04). These results suggest that dietary supplementation of PFA for 35 or more days prior to breeding increases litter size by improving early embryo survival rather than increasing ovulation rate.

Treatment	Control	PFA at entry	PFA-8d entry	SEM
Sows Allotted	223	232	209	
Sows Farrowed	142	157	135	
Total Born	11.3 ^a	11.4 ^a	12.0 ^b	0.26
Live Born	10.2 ^a	10.2 ^a	10.9 ^b	0.25

^{a,b} Means within row lacking common superscripts are significantly different P<0.05.

Key Words: Polyunsaturated Fatty Acids, Litter Size, Embryo Survival

213 The effects of a carbohydrate- and protein-based feed supplement on sow and litter performance. R. L. Payne*, R. D. Lirette, T. D. Bidner, and L. L. Southern, *Louisiana State University*.

Ninety-one primiparous and multiparous sows and their pigs were used to evaluate the effects of a novel carbohydrate- and protein-based feed ingredient (Nutri-PalTM, NP) on sow and litter performance during lactation. The dietary treatments were a corn-soybean meal control and a corn-soybean meal plus 5% NP fed from d-110 of gestation to weaning. The diets were formulated to be equal in total Lys and ME. Sows were allotted to treatment based on parity, weight, and date of d-110 of gestation. There were 46 and 45 sows per treatment over four farrowing groups. Litters were standardized to 10 pigs and weighed within 1 d of farrowing, and all sows weaned at least eight pigs at an average age of 21 d. Sows were weighed on d-110 of gestation, d-1 postfarrowing, and at weaning. Sows were fed three times daily during lactation. Sows were checked daily after weaning for signs of estrus. The weaning weight of sows fed NP was increased ($P < 0.10$) compared with those fed the control diet. Sows fed the control diet tended ($P = 0.11$) to lose more weight per day from d-110 of gestation to weaning compared with the sows fed NP. Otherwise, sow response variables (sow d-110 of gestation and d-1 postfarrowing weight, d-110 of gestation to d-1 postfarrowing and lactation weight change per day, d-110 of gestation to d-1 postfarrowing, lactation, and total feed intake, days to estrus, pigs born alive or dead, and litter and average pig birth weight) were not affected ($P > 0.10$) by diet. There were no effects ($P > 0.10$) of diet on litter performance response variables (pigs weaned, litter and average pig weaning weight and gain, and percentage survival). The NP feed ingredient had minor effects on sow productivity, but it did not affect litter productivity indices.

Key Words: Estrus, Lactation, Sow

214 Sow and litter responses to dietary trace mineral source and level over two parities. J. C. Peters* and D. C. Mahan, *The Ohio State University*.

One hundred two sows involving 182 farrowings over two parities were used to evaluate the effects of trace mineral source and level on sow reproductive performance. The experiment was a $2 \times 2 + 2$ factorial, conducted in a split-plot design with repeated measures. The first factor evaluated organic and inorganic sources of trace minerals (Cr, Cu, Fe, Mn, Se, and Zn) fed to developing gilts and sows while the second factor evaluated their dietary level. One level met NRC (1998) standards (NRC) while the second level was set at normal industry standards (IND, range of 150 to 240% increase). Developing gilts were fed both sources at NRC and IND levels and initiated at 30 kg BW. From breeding through parity two, two additional treatments were evaluated, which involved the IND level for both trace mineral sources but with additional Ca and P (IND+CaP). Litters were equalized within 3 d postpartum. Gestation weight gains ($P < 0.05$) and backfat thicknesses ($P < 0.01$) were lowest when sows were fed the IND level. Return to estrus interval was reduced

by 1 d ($P < 0.05$) for sows fed the IND+CaP level for both trace mineral sources. Fewer sows fed the inorganic IND level completed the study compared to the NRC and IND+CaP levels. Sows fed the organic trace mineral source tended to farrow more ($P < 0.15$) total pigs (11.5 vs. 10.9) with heavier ($P < 0.01$) litters at birth (18.6 vs. 17.2 kg). Number of pigs born (total and live) and litter birth weights were greater ($P < 0.05$) for sows fed the NRC level than IND and IND+CaP levels. Pig weights at d 7 and weaning (17d), and pig daily gains were greater when sows had been fed the organic source at NRC and IND+CaP levels, but not at the IND level, resulting in a source \times level interaction ($P < 0.05$). These results indicate that sows fed organic trace minerals had more pigs born and greater pig gains during the nursing period. Reproductive performance over two parities was not improved by feeding higher dietary levels of trace minerals of either source.

Key Words: Sows, Lactation, Trace minerals

215 Effect of body weight and reproductive status on phosphorus digestibility and efficacy of phytase in pigs. R. Sulabo*, R. C. Thaler, and H. H. Stein, *South Dakota State University*.

An experiment was conducted to determine the effect of BW and reproductive status on the apparent ileal (AID) and apparent total tract (ATTD) digestibility coefficients of P, and the efficacy of phytase in pigs. Six growing pigs (10 to 40 kg BW), six finishing pigs (40 to 130 kg BW), and 6 sows were surgically fitted with a T-cannula in the distal ileum and used in the experiment. Two experimental diets were formulated. Diet 1 was a corn-soybean meal-canol meal-based diet containing 0.45% total P. Diet 2 was identical to diet 1, except that 500 FYT/kg of *Peniophora lycii* phytase (Ronozyme P) was added to this diet. The Ca to total P ratio was 1.1:1 in both diets. Chromium oxide was included in the diets at 0.25% as an inert marker. In the growing and finishing pigs, AID and ATTD of P were determined at 10, 20, 40, 70, 100, and 130 kg BW. In sows, AID and ATTD were determined in each trimester of gestation and in lactation. In growing pigs, BW had no effect on AID or ATTD regardless of the diet being fed. In finishing pigs, AID and ATTD decreased linearly ($P < 0.01$) as BW increased from 40 to 130 kg. In both growing and finishing pigs, phytase supplementation improved ($P < 0.05$) both AID and ATTD. A linear increase ($P < 0.01$) in AID and ATTD was observed as sows proceeded through gestation and lactation, but phytase addition increased ($P < 0.05$) AID only in lactation; no response was observed in any of the trimesters of gestation. Phytase improved ($P < 0.05$) ATTD during late gestation and lactation, but not during early and mid gestation. There were no differences between AID and ATTD in pigs and sows fed the control diet. This was also the case for growing pigs and sows fed the phytase supplemented diet. Results from this experiment demonstrate that both BW and the physiological status of the animal influence the digestibility of P in pigs. The addition of microbial phytase improves the digestibility of P in all groups of animals except gestating sows. It is also concluded that ileal and total tract digestibility coefficients are identical.

Key Words: Digestibility, Phosphorus, Pigs

Odor and Nutrient Management

216 N-CyCLE, a tool to study the feeding and cropping strategies of a farm as a single unit of management. V. R. Moreira¹, M. A. Wattiaux*¹, D. Pellerin², E. Charbonneau², and S. A. Flis¹, ¹University of Wisconsin, ²Université Laval.

Several models have been developed in recent years to describe the impact of management practices on nitrogen (N) and phosphorus (P) balances of a farm. N-CyCLE (Nutrient-Cycling Crops Livestock Environment) was developed using the Linear Programming feature of Microsoft[®] Excel[®] to optimize feeding program, cropping system and manure allocation as a single unit of management within a farm. In N-CyCLE, nutritional requirements for feeding groups ($n \leq 5$), can be met with home-grown feeds ($n \leq 10$) and/or purchased feeds ($n \leq 10$) and nutrient needs for crop rotations ($n \leq 5$) grown in different fields ($n \leq 5$) can be met with manure nutrient and/or purchased fertilizers ($n \leq 4$). The model maximizes income, or minimizes P balance, or minimizes N balance of the whole-farm by choosing the mix of home-grown feed and purchased feed to meet nutritional requirements of each pre-defined animal group and selecting a crop rotation, manure allocation

and fertilizer need for each field. Program outputs include net income, and whole-farm N and P balances, a crop fertilization plan, and a feeding program. The model was used to assess the impact of dietary P on income and whole-farm P balance when the objective was set to either maximize income or minimize P balance on a 192.4-ha farm with 380 cows. Results indicated that reducing dietary P by 20% to NRC (2001) recommendations increased income by \$4,000 and reduced P balance by 1,100 kg (8,847 vs. 7,775 kg). Although crop rotation remained essentially unaltered, purchase of dicalcium phosphate was dramatically reduced (12.7 vs. 3.7 tons per year). When minimizing P balance, corn byproducts (corn distillers and corn gluten meal) were replaced by soyhulls, regardless of P level in the diet. N-CyCLE is a tool that provides benchmark values for whole-farm N and P balances that can be used to explore the economic impact of altering management practices to meet a user-defined environmental outcome.

Key Words: Simulation Model, Nutrient Management

217 Impact of cleaning frequency on nitrogen balance in open feedlot pens. C. B. Wilson*, G. E. Erickson, C. N. Macken, and T. J. Klopfenstein, *University of Nebraska*.

The objective of this experiment was to evaluate pen cleaning frequency and the impact on N volatilization during the summer months when volatilization is the highest and during composting of manure. Either monthly cleaning (MC) or cleaning pens at the end of the feeding period (EC) were evaluated during the summers of 2001 and 2002. In 2001, 432 yearling steers in 54 pens and in 2002, 384 yearling steers in 48 pens were utilized. The pen space per steer was equal in both years with 27 m² per steer. Pens were designated in each experiment as MC or EC. Within each cleaning frequency, collected manure was composted. Manure collected from pens was sampled at cleaning and weighed. Manure analysis was utilized to evaluate DM, OM and N recovery from the feedlot pen over the entire feeding period. Compost was sampled when composting was finished and OM and N recovery were evaluated based on cleaning frequency. The amounts of DM and N removed were increased ($P < 0.01$) if pens were MC compared to EC. By MC, N removal was increased 3.95 kg per steer or a 69.0% increase above manure N removed at the end of the feeding period in 2001. Monthly cleaning in 2002 increased manure N removal 2.5 kg per steer or a 34.8% increase above manure N removed at the end of the feeding period. Intake of N was similar across treatments in both years ($P > 0.05$). Nitrogen loss was significantly higher for the EC cleaning treatment than for the MC treatment in both years. In conclusion, MC was more effective in recovering N in manure and reducing the overall loss from the pen surface. Monthly cleaning reduced the total N loss to the environment by an average of 3.6 kg per hd. Nitrogen recovery percentages were evaluated after composting utilizing total ash as an internal marker. N recovery was similar between pen cleaning treatments with 57.1% for EC and 54.9% MC. These data suggest if manure can be collected and windrowed to decrease surface area exposed to the atmosphere, then cleaning pens more frequently may be a possible method to increase manure or compost N and decrease N losses.

Key Words: Nitrogen, Cattle, Compost

218 Crop performance and soil properties of sites previously used for production of beef cattle manure compost. C. B. Wilson*, G. E. Erickson, D. Ginting, B. Eghball, D. T. Walters, and T. J. Klopfenstein, *University of Nebraska*.

Composting manure on earthen sites can increase nitrate (NO₃), P, and Na levels in the soil under the compost windrows. When the composting operation is terminated, there is a need to reclaim the sites for agricultural crops. The objective of this study was to evaluate soil properties and performance of corn, sorghum, barley, winter wheat, and alfalfa on land previously used as composting sites, and to arrive at recommendations on how to best return such composting sites to agricultural production. Two sites were used for 3 yr and 7 yr of beef cattle manure composting. The 3 yr and 7 yr sites were made into 32 plots (2 reps /crop/composting time) including 3 windrows and 4 inter-windrow spaces. Soil samples from 0-1 m depth were collected from 7 locations, 4 m apart in each plot. Grain crops and alfalfa were planted for either a one or two yr period following initial soil sampling. Alfalfa was planted on all plots after the last grain crop was harvested to scavenge nitrate from the soil profile. Soil K, Na and NO₃ levels in the windrow areas were greater than those in the inter-windrows at 15.2 cm depth. Maximum windrow soil K, Na and NO₃ were 4078, 242 and 73 ppm respectively. Leaching of K, Na and NO₃ were time dependent and moved deeper into the soil profile with increasing composting time. In the first yr crop barley, wheat or sorghum made some growth. Cropping and tillage in yr 1 resulted in dilution of K, Na and NO₃ which improved soil surface structure. Yields of grain crops and alfalfa DM were similar between the windrows and inter-windrows in yr 2, indicating effectiveness of cropping and field cultural practices in rehabilitating these sites. Areas that are used for composting can be rehabilitated by using tillage and growing crops for at least one yr before alfalfa is established to remove excess nitrate deep in the soil profile.

Key Words: Composting, Nitrate, Salt

219 Determination of nitrogen digestibility, retention, and dilution using ¹⁵N labeled corn in diets of growing pigs. H. A. Rachuonyo* and M. Ellis, *University of Illinois*.

The objectives of this study were to determine ¹⁵N digestibility, retention, and dilution in feces and urine of growing pigs fed labeled and unlabeled corn. Corn containing varied concentration of ¹⁵N in grain was obtained from a study conducted to identify fertilizer application techniques that could maximize efficiency of ¹⁵N uptake into grain, determine variety differences in ¹⁵N efficiency, and identify potential differences due to application rates. A total of 12 barrows (BW=20.0 ± 1.28 kg, 4 pigs/diet) were used in a completely randomized design, with 3 treatments: a) Control (unlabeled corn), b) Low (N% atom 3.5), and c) High ¹⁵N (N% atom 4.1). All animals were weighed at start and end of study. Pigs were kept in crates for a period of 11-d, of which 5-d were for acclimation and 6-d for sampling. All animals were fed at 70 % of predicted ad libitum intake based on initial BW. Chromium oxide (0.2%) was used as a marker to start and end collection periods. Fecal sampling started and ended when marker was observed in feces, while urine started and ended 4-h after adding marker. There were no differences ($P > 0.05$) among diets in ADFI, ADG, and BW. Diets with ¹⁵N label, however, resulted in greater ($P < 0.01$) amounts of ¹⁵N label in feces (0.43 vs. 2.04 vs. 2.06 N atom; SEM=0.142 for Control, Low and High ¹⁵N diets, respectively) and urine (0.40 vs. 1.37 vs. 1.38; 0.036) than in Control diet. Urine N was not different ($P > 0.05$; 0.27 vs. 0.49 vs. 0.31%; 0.139) but fecal N was higher ($P < 0.05$) for Low ¹⁵N than for Control and High ¹⁵N (2.63 vs. 3.26 vs. and 3.10%; 0.179) diets. N excreted in urine and feces/d was not different ($P > 0.05$) among diets. There were no differences ($P > 0.05$) in N digestibility (61.23 vs. 46.17 vs. 59.41%; SEM=5.562), balance (17.94 vs. 8.43 vs. 14.32; SEM=5.463), and retention (31.89 vs. 13.73 vs. 23.10% of intake; SEM=9.734, for Control, Low and High ¹⁵N diets, respectively) among diets. This study provides evidence that ¹⁵N atom can be used to trace nitrogen flow from grain, into the animal, and back to field.

Key Words: Labeled 15N Corn, Nitrogen Balance, Waste Management

220 Nutritional value of processed corn products. N. S. Muley*, A. J. Moeser, E. van Heugten, and T. A. T. G. van Kempen, *North Carolina State University*.

The present experiment was designed to assess if corn fractions or extrusion of corn can result in feed ingredients with a higher nutritional value than corn. Corn (8.0% CP, 0.18% P, 9.8% NDF) was processed by extrusion (82.8degC, 3.3 bar steam for 12 s) or by dry milling to derive germs (13.1% CP, 0.92% P, 17.2% NDF), hulls (8.1% CP, 0.27% P, 32.6% NDF), and the endosperm fractions tails (6.6% CP, 0.05% P, 3.6% NDF), and thrus (7.4% CP, 0.11% P, 4.5% NDF). Recovery in each fraction was 16, 20, 44, and 20%, respectively. These fractions were formulated into diets containing 7.0% CP from soybean meal and 5.3% CP from each of the fraction (balance was corn starch and vitamin/mineral premix for all test diets). The objectives of the experiment were to determine the ileal digestibility of DM, P and amino acids. To allow for determination of standardized ingredient digestibility, basal endogenous losses were determined using a protein-free diet (74.6% corn starch and 18.7% sucrose) and soybean meal digestibility was determined using a diet (12.3% CP) based on soybean meal. Eight barrows (27 Kg) fitted with T cannulas were fed the eight diets using a Latin square design (5 d adaptation and 2 d collection). Relative to corn (77.9±1.5%), digestibility of DM was higher ($P < 0.05$) for extruded corn (82.6%), tails (85.9%) and thrus (85.0%) while it was lower ($P < 0.05$) for hulls (62.2%) and germs (51.2%). For P, corn (41.6±10.1%), thrus (47.2%) and hulls (57.3%) had similar ($P > 0.10$) digestibility, while germ (7.9%) had lower digestibility ($P < 0.05$) than corn. Tails (27.6%) and extruded corn (23.5%) were intermediate. For total amino acids, corn (84.7±2.9%), thrus (84.3%) and hulls (85.8%) had similar ($P > 0.10$) digestibility, while germ (76.6%) had lower digestibility ($P < 0.05$) than corn. Tails (82.0%) and extruded corn (81.8%) were intermediate. In conclusion, germ and hulls have a low DM digestibility, and germ also has a low amino acid and P digestibility. Extrusion improved the DM digestibility of corn. In order to maximize the digestibility of feeds (to minimize nutrient waste) removal of germ and hull from corn or extrusion of corn may thus be of interest.

Key Words: Corn, Ileal Digestibility, Swine

221 The effects of reducing dietary crude protein and adding chicory on composition and odor of stored swine manure. S. M. Hanni*, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University*.

Our objective was to evaluate the nutrient excretion and odor reducing potential of chicory, a feed ingredient containing inulin, in either a corn-soybean meal diet or a diet formulated to minimize nutrient excretion and odors using crystalline amino acids, phytase, and non-sulfur-containing trace minerals. Treatments were arranged in a 2 x 2 factorial with main effects of diet nutrient excretion potential (low and high) and chicory (0 or 10%). Twelve barrows (initially 59 kg) housed in metabolism crates were fed each of the four diets over four 10-d periods in a replicated 4 x 4 Latin square. Feces and urine were collected from d 4 to 6 to measure N, S, and P intake, excretion, and retention. Feces and urine were collected on d 8 and 9 of each period and mixed into a 7.5% DM slurry for odor analysis. The 7.5% slurries were sampled on d 28 and 56 of storage for measurement of pH, total Solids (TS), total volatile solids (TVS), ammonia, total Kjeldahl N (TKN), H₂S, total sulfur (sum of all sulfur in air and slurry), and Ca, K, Mg, Na, and P. Air samples collected from slurries were measured for H₂S, intensity, and offensiveness. Pigs fed diets formulated to reduce nutrient excretion and odor had a 20% and 34% reduction (P < 0.001) in total N and P excretion, respectively, and 33% reduction in urinary S excretion. Addition of chicory to the diet further reduced (P < 0.002) N and P excretion by 10% and 14%, respectively. Pigs fed the diets formulated to reduce nutrient excretion and odor had lower (P < 0.001) pH, ammonia, S, and TKN in the slurry samples. However, H₂S emission, odor intensity and offensiveness were not affected (P < 0.19) by treatment. These results indicate that formulating a diet to meet the needs of a pig yet lower nutrient excretion by use of synthetic amino acids, phytase, non-sulfur containing trace minerals and the addition of chicory reduce nutrient excretion in swine manure, but do not appear to affect the intensity or offensiveness of odors.

Key Words: Pig, Chicory, Odor

222 Effect of feeding a low nutrient excretion diet on wean-finish pig growth performance, carcass characteristics, manure composition, and building aerial ammonia. R. B. Hinson*, B. E. Hill, M. C. Walsh, D. M. Sholly, S. A. Trapp, J. S. Radcliffe, A. L. Sutton, A. P. Schinckel, and B. T. Richert, *Purdue University*.

One hundred forty-eight pigs were used to determine the effects of feeding a corn SBM based diet (CTRL) or a low nutrient excretion (LNE) diet, formulated with reduced CP plus synthetic amino acids, low phytic acid corn, and phytase on wean-finish growth performance, manure generation and composition, building aerial NH₃ emissions, and carcass characteristics. Pigs (5.95 kg BW) were blocked by sex and BW and randomly allotted to CTRL or LNE diets. Pigs were housed in 4 nursery and 2 grow-finish (G-F) rooms, with individual and identical manure pit and ventilation systems. Pigs were split-sex phase fed, three nursery diets for a 5 wk nursery period and 2 grower and 2 finisher diets for a 16 wk G-F period. Pigs were housed 4 or 5 pigs/pen with 9 pens/trt/sex during the nursery period and 4 pigs/pen with 5 pens/trt/sex in the grower phase and 2 pigs/pen in the finisher phase. On wk 8 and 16, 10 pigs/trt/sex were slaughtered for determination of carcass characteristics. Ultrasonic estimates of backfat depths and loin eye area (LEA), manure depths and samples and aerial NH₃ values were taken at the end of each growth phase. Growth performance was unaffected (P>0.05) by diet during any of the growth phases, except for G:F (P<0.05) during the nursery (CTRL=.67, LNE=.62) and grower phases (CTRL=.45, LNE=.41). Diet had no effect (P>0.05) on final 10th rib carcass characteristics. Nursery and G-F phase manure volumes, pH, and ammonium-N concentrations were reduced by LNE diets. Aerial NH₃ were reduced 60% during the nursery and 46% at wk 8 of the G-F phase by the LNE diet. Feeding a reduced CP and phosphorus diet sustained pig growth performance and ribbed carcass data when fed from wean-finish, while reducing nutrient excretion.

Key Words: Pigs, Nutrient Excretion, Reduced Crude Protein

223 Nitrogen excretion and ammonia emissions from pigs fed reduced crude protein diets. D. Panetta*¹, W. J. Powers¹, H. Xin¹, B. J. Kerr², and J. C. Lorimor¹, ¹Iowa State University, ²USDA-ARS NSRIC.

Two experiments were conducted to quantify the effects of dietary strategies on NH₃ emissions of growing-finishing pigs. In Exp 1, nine pigs (initial BW = 47 kg) were fed corn-soybean meal diets fortified with no amino acids (17.4% CP), Lys (17.0% CP, DM basis), or Lys, Met, Thr, and Trp (14.5% CP). In Exp 2, nine pigs (initial BW = 41 kg) were fed the Lys diet with 0, 62.5 or 125 ppm of yucca extract (Alltech). Two gilts and one barrow were allocated to each of three indirect calorimeters. Four 1-wk feeding periods, with new diets assigned weekly, consisted of a 4-d dietary adjustment followed by 72 h of continuous NH₃ measurement from chamber exhaust. Pigs and feed refusals were weighed, urine and fecal samples collected, and manure pits cleaned after each period. Feed intake (FI) and gain (ADG) were measured each period. Diets, urine, and fecal samples were analyzed for TKN and NH₃-N concentration. In Exp 1 and 2, diet had no effect on FI, ADG, or feed efficiency (P > 0.05). In Exp 1, TKN in feces (3.97, 3.93, 3.72%; P < 0.001) and urine (1.10, 0.94, 0.93%, P = 0.04) decreased with decreasing dietary CP. Fecal NH₃-N decreased with decreasing dietary CP (0.47, 0.47, 0.42%, P = 0.01) while urine NH₃-N increased (0.10, 0.10, 0.20%, P < 0.001). Weekly NH₃-N emissions were 22.25, 19.22, and 11.85 g/chamber (± 8.87 SEM; P > 0.05). The fraction of excreted TKN emitted as NH₃ during the week was 1.68, 1.52, and 0.91% (± 0.60 SEM; P > 0.05). In Exp 2, there was a linear decrease in urine NH₃-N due to increasing yucca content (0.14, 0.13, 0.11%, P = 0.05). Fecal TKN (3.59% ± 0.06 SEM), fecal NH₃-N (0.48% ± 0.03 SEM), urine TKN (0.94% ± 0.07 SEM), NH₃-N emissions (12.02 g ± 2.81 SEM) and the fraction of excreted TKN emitted as NH₃ during the week (1.20% ± 0.24 SEM) were not affected by yucca inclusion (P>0.05). Reducing diet CP and including NH₃-binding agents can be effective in reducing N content of excretions and NH₃ emissions. Less than 2% of excreted N was volatilized as NH₃ during the collection period.

Key Words: Ammonia, Crude protein, Yucca

224 Effect of feeding a reduced crude protein and phosphorus diet on grow-finish pig growth performance, carcass characteristics, manure concentration, and building aerial ammonia. R. B. Hinson*, D. M. Sholly, M. C. Walsh, B. E. Hill, S. A. Trapp, J. S. Radcliffe, A. L. Sutton, A. P. Schinckel, and B. T. Richert, *Purdue University*.

Fifty barrows and forty-eight gilts (Initial BW= 32.0 kg) were allotted by sex and BW to determine the effects of feeding a control (CTRL), corn-SBM based diet or a low nutrient excretion (LNE) diet, formulated with reduced crude protein plus synthetic amino acids, low phytic acid corn, and phytase, on grow-finish (G-F) pig growth performance, carcass characteristics, and building aerial gasses. Pigs were housed 5 pigs/pen and 5 pens/sex/trt during the grower phase (wk 0-8) and three pigs/pen during the finisher phase (wk 8-16) in one of two identical environmentally controlled rooms with separate ventilation and manure storage. Feed was split-sex and phase fed with two grower diets and two finisher diets. Individual pig weights and pen feed consumption were recorded bi-weekly. Manure depths and samples and aerial ammonia values were taken at the end of each growth phase. Pigs were ultrasonically scanned at wks 2, 8, and 16 to determine backfat depths and loin eye area (LEA). Ten pigs/sex/trt were slaughtered at wk 8 and 16 for determination of carcass characteristics. Growth performance was not different between treatments (P>0.05) during the grower, finisher, or overall G-F period, except for grower ADG (CTRL=.87 kg/d, LNE=.83 kg/d). There were no differences (P>0.05) in 10th ribbed carcass data at wk 16. The LNE diet increased wk 2 ultrasound 10th rib backfat, and decreased wk 8 and 16 ultrasound LEA (P<0.05). LNE pigs produced a numerically larger volume of manure per day. However, ammonium-N, nitrogen, and phosphorus excreted per pig per day were numerically reduced when pigs were fed the LNE diet. Average aerial ammonia concentrations were reduced 36.5% by the LNE diet. Feeding a reduced crude protein and phosphorus diet can maintain growth performance and ribbed carcass characteristics, while reducing nutrient excretion in G-F swine.

Key Words: Pigs, Nutrient Excretion, Reduced Crude Protein

225 Phosphorus transformation in swine manure due to diet and intermittent aeration treatments. Q. M. Yang*, S. K. Baidoo, and J. Zhu, *Southern Research and Outreach Center, University of Minnesota*.

An experiment was conducted to study the transformation of phosphorus (P) in manure from pigs fed two different diets, a control corn soybean meal diet with or without supplement of 9% sugar beet pulp (SBP). Manure was collected and treated with either no aeration or intermittent (on/off ratio = 10:14hrs) aeration at an airflow rate of 0.6 L/sec/m³ for 15 d in stimulated columns (Height = 96cm; Diameter = 15.6cm). Manure sources (control corn-SBP or SBP-supplemented) and processing (aeration or no aeration) were performed in a 2 × 2 factorial design study. The results indicated that aeration increased (P<0.01) the manure pH by 0.5-0.8 unit within 24 hours, from 6.5 to 7.0 for the SBP manure, and from 6.9 to 7.7 for the control manure. The pH reached 7.6 and 8.0 for the SBP and control manure in 3-4 days. The average pH of the SBP manure was lower (P<0.01) than that of the manure from the control diet (6.67 vs. 7.38). However, there was little change in pH in the non-aerated manure. Aeration decreased insoluble inorganic P, and soluble P, but increased organic P by approximately 30 mg/L. The average organic P in the manure for both diets with aeration was about 17.4% higher than that in the manure without aeration. Aeration decreased (P<0.05) insoluble inorganic P by about 7.2% and soluble P by about 4.5%. The P fractions showed transformation of insoluble inorganic P into organic forms during the aeration stage. The manure contained about 68% insoluble inorganic P of the total P, so it is essential to perform solid-liquid separation prior to aeration to enhance the efficiency of soluble P removal because insoluble inorganic P is mainly contained in the manure solids. In conclusion, aeration increased manure pH and organic P content compared to anaerobic storage of the manure. SBP supplementation decreased manure pH, but did not affect phosphorus transformation.

Key Words: Pig Manure, Aeration, Phosphorus

226 The characterization and environmental impacts of crust associated with deep pit stored swine manure and the potential for using an enzyme treatment as a method for control. T. D. Parrott* and A. J. Veldkamp, *Agtech Products, Inc.*

A study was conducted to examine the composition and environmental impact of crust associated with deep pit manure storage facilities. The composition of fecal and pit crust samples collected from four independent swine production facilities was determined. Analysis of insoluble particles larger than 180 μm showed that over 40% of the total dry matter in fecal material contained a thin "winglike" material whose nutrient composition was 36% protein, 33% nitrogen free extract and 21% fiber. The composition of this material was similar to that found in the pit crust samples. The ability of an enzyme treatment to decrease pit crust buildup and minimize potential production impacts was determined using in-house ammonia and fly populations as environmental indicators. Two finishing barns from each of two sites exhibiting significant pit crust were monitored over an eight week period. Fly populations were quantitated by hanging four evenly distributed adhesive cards over pens throughout each barn. Fly populations were monitored once per week for three to six times over the eight week period depending on the site. Ammonia concentrations were obtained from four representative areas within each barn. One barn from each site received the enzyme treatment. The remaining barn received no treatment and served as a control. Pit crust levels were reduced up to 60% in treated finishing barns compared to controls. Barns receiving the enzyme treatment had 39% less flies compared to control barns (p<0.05). General observations indicate that the prevalence of flies is directly proportional to the amount of pit crust. Lower ammonia concentrations were correlated to a reduced amount of pit crust (r²=0.90). Overall, this study demonstrated how pit crust affects specific environmental parameters such as flies and ammonia. Furthermore, the enzymatic treatment of pit crust may help to reduce its negative impact on swine production.

Key Words: Manure, Ammonia, Flies

Physiology

227 Problems with return to estrus in sows, timing of puberty and seasonal anestrus: a pork production perspective. S. L. Terlouw*, *Minitube of America*.

Lifetime sow production is optimized by 1)minimizing the number of non-productive days and 2)maximizing life span. Three factors that impact non-productive sow days are anestrus sows, timing of puberty, and seasonal infertility. Sows that resume estrous activity on days 4-to-6 post weaning (day 0) produce larger litter sizes and higher farrowing rates. Parity, length of lactation, nutrition, environment, management, health and genetics impact return to estrus. Pools of anestrus sows are the most poorly managed sows even though they need the most individual attention. The primary limitation is that their ovarian status is not known. Understanding the mechanisms controlling anestrus, and causes for cyclic sows to not be detected in estrus, may provide information on how to manage specific anestrus situations. Variation in the timing of puberty in gilts is another significant problem. This variation adds significant costs for building space and labor. Methods to manage puberty suffer from variation in response and facility and labor cost needed for implementation. Producers need to know how to manage puberty, what percent of gilts to expect in estrus, when to breed gilts after puberty (age, wt., BF), and how to manage gilts to develop into productive sows. Seasonal patterns of reproduction in swine are well documented. Intensive selection for reproduction in pigs through all seasons has likely removed most feral seasonal breeding characteristics. However current production data show seasonal variation. Seasonal variation within and between farms raises questions about the true causes of seasonal anestrus in the pig. Important questions are: What are the factors that predispose a female to become infertile in a seasonal pattern? What management factors should be considered to mitigate the impacts of season on breeding-herd productivity? Are pigs really seasonal breeders? Therefore, although the environment and management of swine breeding herds is closely controlled, there are many unexplained reproductive problems that require scientific investigation.

Key Words: Season, Anestrus, Puberty

228 The follicular phase in pigs: follicle populations, circulating hormones, follicle factors and oocytes. H. D. Guthrie*, *Biotechnology & Germplasm Lab, USDA, ARS Beltsville Agricultural Research Center*.

Selection of the ovulatory cohort of follicles from a population of similar sized follicles is a critical event in follicular development. During the estrous cycle the number of 3-6 mm follicles ranges from 30 to 45 per gilt between days 7-15. Of this population, 35-50% are atretic and during this period of luteal dominance, even the non-atretic follicles have low levels of steroidogenesis. The maintenance of a proliferating population of 1-2 mm and 3-6 mm follicles is critically dependent on circulating FSH. Natural or experimentally induced reduction in circulating FSH levels or FSH treatment results in a rapid decrease or increase in numbers of 1-6 mm follicles, respectively. The mechanisms that regulate the selection of ovulatory follicles are not well understood. However, the ovulatory cohort appears to shift from FSH- to LH-dependence at the expense of the non-ovulatory follicles by causing a decrease in FSH secretion and by increased expression of the LH receptor and LH binding capacity relative to non-ovulatory follicles. Selection and maintenance of ovulatory follicles are associated with increased production or activity of intraovarian factors such as estradiol, the IGF system, and inhibin/activin peptides. Treatment regimens such as eGC or PG600 are beneficial for treatment of anestrus and, in conjunction with hCG or GnRH analogues, provide better control of the time of ovulation and increased ovulation rate; however litter size has not been increased. The use of various FSH preparations to better control ovulation rate and improve fertility have not been successful. Genetic improvement of ovulation rate and fertility traits has been made through direct and index selection, but genes specifically responsible selection of ovulatory follicles have not been identified. Functional genomics approaches that integrate genetic and physiological aspects of ovulatory follicle selection have the potential improve fertility and provide new basic knowledge of genetic regulation of the physiological mechanisms involved.

Key Words: Ovulation, Atresia, Gonadotropin

229 Potential management and pharmacological interventions for regulating follicle growth in gilts and sows. G. Foxcroft*, J. Barry, and W. Dixon, *University of Alberta*.

Interventions affecting follicular development can achieve a number of different outcomes. Firstly, the aim can be stimulation of follicle development in otherwise anovulatory females. The cause of anovulation will dictate interventions that produce a stimulatory effect. Inadequate growth rate in gilts, and a catabolic state in weaned sows, can be alleviated with improved nutritional management which likely acts at all levels of the reproductive axis to enhance follicular development. Suppression of follicular development due to suckling is centrally mediated and a reduction in suckling intensity and duration can trigger increased follicular development. At least in the late pre-pubertal gilt, a lack of gonadotropic support for the emergence of estrogenic, pre-ovulatory, follicles can be counteracted by the endocrine response to boar pheromones. In all situations in which a lack of gonadotropic stimulation limits follicle development, exogenous combinations of gonadotropins can be efficacious in triggering follicular growth and ovulation. However, use of exogenous gonadotropins may not result in optimal sow fertility, unless associated problems of inadequate nutrition are also addressed. Secondly, the objective may be to enhance the number and quality of follicles at the time of ovulation. Genotype and metabolic state affect both aspects of follicular development. However, if increased ovulation rate is to improve sow productivity, then limitations of follicle and oocyte quality, and uterine capacity, must also be addressed. Thirdly, temporal control of follicular development allows synchronization of estrus and ovulation. A limited period of sensitivity to luteolytic effects of prostaglandins, and the naturally high circulating concentrations of progesterone, results in the use of exogenous oral progestagens being the only practical technology currently available for estrus synchronization in swine.

Key Words: Swine, Follicle, Regulation

230 Factors affecting the development of preantral follicles in cattle. R. A. Cushman*, M. F. Allan, and S. E. Echternkamp, *USDA, ARS, U.S. Meat Animal Research Center*.

Preantral follicles comprise the largest portion of the follicles in the mammalian ovary, but the factors controlling activation of primordial follicles into the growing pool and growth of preantral follicles are poorly understood. Studies using transgenic mice and cultures of whole rodent ovaries provide most available data; however, information is beginning to accumulate for domestic ruminants. A number of model systems have demonstrated that, while beneficial, the gonadotropins, FSH and LH, are probably not required for early folliculogenesis. However, several members of the transforming growth factor- β super family, including growth differentiation factor-9 (GDF-9), bone morphogenic protein-15 (BMP-15), and anti-Müllerian hormone (AMH), have demonstrated roles in activation and/or growth of preantral follicles in both rodent and ruminant models. MARC cattle selected for multiple ovulations have greater numbers of preantral and antral follicles, and provide a unique polygenic model for examining factors controlling preantral follicle development. It is unclear whether the increased ovulation rate in these cattle is due to increased numbers of primordial follicles or whether there are physiological mechanisms involved in enhanced follicular development beyond the primordial stage. Evidence from sheep indicates mechanisms that enhance follicular development. Booroola sheep have a mutation in the bone morphogenic protein receptor-1B (BMPR-1B) which results in an increased number of ovulations, and an inactivating mutation in the BMP-15 gene in Inverdale sheep blocks folliculogenesis at the primary stage, similar to GDF-9 deficient mice. No genes with a major effect on ovulation rate have been identified in the MARC Twinner cattle, but there is a QTL on chromosome 7, which maps closely to the GDF-9 and AMH genes. Treatment of ovarian cortical cultures with AMH decreased the diameter of primary follicles after 10 days, implicating AMH as an inhibitor of preantral follicle growth in cattle. Future studies will examine Twinner ovary function in culture.

Key Words: Preantral, Follicles, Cow

231 Factors affecting ovarian follicular development during sexual maturation in heifers. C. L. Gasser and M. L. Day, *The Ohio State University*.

The number of antral follicles that are observed in the ovaries of heifers substantially increases during the first 6 mo after birth, with the maximum number present by approximately 6 mo of age. Dynamic changes in this follicle population, indicative of the initiation of wave-like growth of ovarian follicles have been observed in heifers as early as 2 wk of age. Following the establishment of this wave-like pattern of follicular growth, subsequent changes that can be detected by ultrasonography during maturation include increases in the maximum diameter of the dominant and subordinate follicles, numbers of large antral follicles, and the duration of the succeeding follicular waves. The maximum diameter of dominant follicles and estradiol concentrations continue to increase gradually through the peri-pubertal period to puberty. Follicular growth and associated patterns of gonadotropin secretion in heifers during the late pre-pubertal period have been shown to be similar to that of adult cows. Additionally, substantial evidence exists for competence of the hypothalamic-pituitary-ovarian axis during prepuberty, as the components of this system have been shown to function in an adult-like manner in prepubertal heifers if afforded the proper stimulus or release of inhibition. Precocious puberty (< 300 d of age) has been observed to occur spontaneously in up to 25% of beef heifers and can be experimentally induced in over 85% of beef heifers that are weaned early and fed a high-concentrate diet. Heifers that experienced precocious puberty displayed advanced increases in maximum diameter of dominant follicles, duration of follicular waves, and peak estradiol concentrations during follicular waves. Further, when maximum diameter of dominant follicles was adjusted to time of puberty, heifers that exhibited precocious puberty were estimated to have ovulated smaller dominant follicles than heifers that did not experience precocious puberty.

Key Words: Puberty, Follicular Development, Heifer

233 Inhibition of vascular endothelial growth factor (VEGF) signaling blocks follicle progression in the perinatal rat ovary. R. M. Pohlmann*¹, D. T. Clopton², R. M. McFee², T. G. Rozell¹, and A. S. Cupp², ¹*Kansas State University*, ²*University of Nebraska*.

Female reproductive life span is determined by primordial follicle pool size produced during fetal development and the follicle depletion rate after birth. Little is known about the regulatory mechanisms involved in primordial follicle development, progression or depletion. VEGF and its receptors, VEGFR-2 and VEGFR-1, are important regulators of follicular development in the adult ovary. In our lab, VEGF mRNA was determined to be expressed in embryonic d 13 (E13) to postnatal d 10 (P10) rat ovaries. Therefore, we hypothesized VEGF regulates follicular development in the perinatal ovary. To test this hypothesis, two experiments were conducted. In experiment 1, ovaries were collected from P3 through P10 rats and immunohistochemistry was conducted to determine localization of VEGF, VEGFR-1 and -2. VEGF was localized to granulosa cells in primordial to pre-antral stage follicles. VEGFR-1 and -2 were expressed in oocytes from all follicle stages with expression in thecal cells of the pre-antral follicle. In the second experiment, ovaries were collected from P3 to P4 rats (n=12 organ pairs) and cultured for 14 d with either no treatment or 8 μ M of a specific VEGF signal transduction inhibitor (VEGFR-TKI). Three histological sections per ovary were examined to determine follicle numbers at each stage of development (0 = primordial, 1 = early primary, 2 = primary, 3 = transitional, 4 = pre-antral). Ovaries treated with VEGFR-TKI had a ten-fold increase in primordial follicle number (stage 0; $P < 0.0001$) and a greater total follicle number ($P < 0.001$) compared to controls. VEGFR-TKI treated ovaries also had fewer stage 2 ($P < 0.001$) and stage 3 ($P < 0.05$) follicles. Results of these experiments indicate that VEGF and its receptors are localized to cells important in follicle development and inhibition of VEGF signaling blocks primordial follicle progression in the perinatal rat ovary.

Key Words: Perinatal Ovary, VEGF, Follicle Progression

234 Double ovulations following induction of luteal regression during ovarian follicular wave emergence in heifers. C. J. Bailey¹, C. R. Burke², M. L. Mussard¹, and M. L. Day¹, ¹The Ohio State University, ²Dexel Research Ltd.

We have previously observed a prevalence of double ovulations when luteal regression was induced concurrently with emergence of a new wave of ovarian follicles following follicular aspiration. Accordingly, the hypothesis that the incidence of double ovulations is increased when follicular emergence and luteal regression occur concurrently, as compared with animals in which luteal regression occurs after follicle selection, was tested in a preliminary study. Estrus was synchronized in yearling beef heifers (427 ± 12 kg BW). On d 0, (5.7 ± 0.1 d following estrus) all follicles ≥5 mm in diameter were aspirated using the transvaginal ultrasound-guided approach. Heifers received PGF_{2α} on either d 1.5 (PG1.5, n = 11) or d 5 (PG5, n = 10). From d 2 through either ovulation or d 10, ovarian activity was monitored daily via transrectal ultrasonography to evaluate follicular development. The d of ovulation was defined as the d the dominant follicle(s) disappeared. Only data from heifers that ovulated by d 10 (PG 1.5, n = 8; PG5, n = 10) were included in the analyses. The d of estrus (6.2 ± 0.3 vs. 8.3 ± 0.2) and ovulation (7.3 ± 0.3 vs. 8.6 ± 0.2) were earlier (P < 0.05) in the PG1.5 than PG5 treatment, respectively. Three heifers in the PG1.5 treatment had double ovulations, whereas all other heifers had a single ovulation (ovulation rate = 1.4 ± 0.2 vs. 1.0 for PG1.5 and PG5, respectively; P < 0.05). Diameter of the largest ovulatory follicle (13 ± 0.3 mm) did not differ among treatments and diameter of the second ovulatory follicle (n = 3) was 10 ± 0.6 mm. The PG1.5 treatment tended (P = 0.06) to increase the number of follicles ≥5 mm in diameter during the period from d 2 to 6. Differential growth patterns of the largest and second largest follicles were not detected between treatments. These findings support the hypothesis that concurrence of luteal regression and emergence of a new wave of ovarian follicles promotes double ovulation in heifers.

Key Words: Follicular Development, Ovulation, Cattle

235 Altered reproductive response in beef heifers fed soybeans during late pubertal development. H. L. Harris*, A. S. Cupp, and R. N. Funston, *University of Nebraska*.

The objective of this study was to determine the effects of the inclusion of soybeans in heifer development diets on synchronization, conception, and pregnancy rates of virgin beef heifers. April-born crossbred females (n=104) weighing 300 kg at 10 months of age were randomly assigned to one of two diets formulated to be isocaloric and isonitrogenous. Heifers received either a control diet or a diet containing 1.36 kg whole soybeans (4% added fat) for 110 d. All heifers were fed melengestrol acetate (0.5 mg/d) for 14 d prior to a PGF_{2α} injection (25 mg) on d 110 to synchronize estrus. Heifers were artificially inseminated 12 hours after visual detection of estrus. Bulls were placed with heifers 10 d after the last AI for a 60 d breeding period. Pregnancy to AI was determined by ultrasonography 45 d after the last AI. Blood samples were collected prior to, during, and at the end of the feeding period (at the time of PGF_{2α} injection). Progesterone was assayed in serum samples to determine estrous activity. There were no differences (P > 0.10) in estrous activity before experimental diets were fed (81%), during (93%), or at the time of PGF_{2α} injection (91%). Soybean-fed heifers had a lower (P < 0.05) synchronization rate (96 vs 81% for control and soybean-fed heifers, respectively) and a delayed (P = 0.05) estrous response to synchronization (2.9 vs 3.2 d after PGF_{2α} for control and soybean-fed heifers, respectively). There were no differences (P > 0.10) in AI conception (76.5%), AI pregnancy (67%), or in final pregnancy rates (92%). The reason for the lower synchronization rate and delayed time of estrus is unknown. However, HPLC analysis of the extracted soybeans indicated the presence of three phytoestrogens: genistein, daidzein, and glycitein. The combination of these phytoestrogens may have induced the altered reproductive response in soybean-fed heifers.

Key Words: Fat Supplementation, Heifer Development, Fertility

236 Effects of estrous synchronization and timed artificial insemination in beef heifers. J. M. Bender*, C. S. Whisnant, and J. P. Cassady, *North Carolina State University*.

The objective of this study was to evaluate estrus synchronization followed by timed artificial insemination in beef heifers. Heifers (n = 126)

at three locations were randomly assigned to treatment groups. All heifers received melengestrol acetate (MGA) for 14 days and an injection of prostaglandin F_{2α} (PGF) 19 days after cessation of MGA. Group 1 was then monitored for signs of estrus and artificially inseminated 12 hours after being observed in standing heat. In addition to treatments described above, Group 2 received an injection of GnRH 12 days after MGA cessation. Group 2 heifers were monitored for estrus for 72 hours after receiving PGF, and heifers observed in standing heat were artificially inseminated 12 hours later. Remaining Group 2 heifers, those not observed in standing heat, received a second injection of GnRH and were inseminated at 72 h after PGF. All Group 3 heifers received injections of GnRH on days 12 and 22 and were inseminated on day 22 after MGA cessation. Data were analyzed using a fixed model including effects of treatment and location. Five heifers at one location had late term abortions. Those heifer's records were excluded from analysis. Of the remaining 121 heifers, 89 calved. Treatment (P < 0.73) and location (P < 0.28) did not affect calving rate. Heifers calving within 291 days of PGF administration were assumed to have conceived at first breeding. Groups 2 (56%, P < 0.01) and 3 (46%, P < 0.03) had a greater proportion of calves born within 291 day of PGF administration than did Group 1 (23%). Groups did not differ for proportion of heifers calving within 309 days of PGF administration (P < 0.17) Timed AI using the above protocol was an effective means of increasing the proportion of calves born early in the breeding season.

Key Words: Beef Cattle, Estrus Synchronization, Reproduction

237 Initial investigation of gene expression profiles of ovarian follicular cyst in dairy cows. Z. Liu*, H. A. Garverick, and E. Antoniou, *Department of Animal Science, University of Missouri*.

Ovarian follicular cysts are anovulatory follicular structures that grow and pass ovulatory size but fail to ovulate. They occur in 10 to 13% of dairy cows and cause an estimated loss of \$150 million annually in USA. Research projects have been carried out to help understanding the mechanisms of the cyst development, but they mainly focus on a few hormones and are not sufficient for revealing the molecular mechanisms associated with cyst formation. We are using DNA microarray to investigate gene expression profiles in ovary follicles. Preliminary data was obtained from self- and cross- hybridizations of two dominant follicles and two cysts, using home-printed cDNA slides containing 1536 probes. The self-self hybridizations indicate gene expression changes greater than 1.46 fold can be classified as differentially regulated at a 95% confidence level. Using this criterion, twenty-two genes were found to be up or down regulated, representing 1.9% of the total number of genes analyzed. This possibly indicates that cysts and dominant follicles differ only by a small number of gene expression changes. A detailed examination of the three genes down regulated in both cysts showed that, while two of them are unique bovine EST sequences with no significant matches in the GenBank database, the other one, CD9, is known to express in human granulosa and theca internal cells. These results showed the potential of using microarray in investigating gene expression profiles and selecting candidate genes.

Key Words: Ovary Follicles, DNA Microarray, Gene Expression Profile

238 Relationships of leptin, backfat, and body weight in gilts. T. Wise* and J. Klindt, *USDA, ARS, U.S. Meat Animal Research Center*.

Today's market pigs have a degree of leanness which may be associated with delayed puberty. It is known that a degree of body fat is required for initiation and maintenance of reproductive function. Leptin produced by adipocytes acts through leptin receptors in the upper brain centers to control appetite and food intake thus communicating information about degree of fatness. To analyze the role of body weight (BW) and backfat thickness (BF) in initiation of first estrus, age of puberty was monitored from offspring of two genetic sire lines representing Duroc (D) and Landrace (L) bred to maternal line White cross gilts. In a second study the D and L sire lines were crossed (DxL) to produce maximum variation. At first estrus, BF was measured ultrasonically at the first rib, last rib and last lumbar vertebrae and BW recorded. The first year 215 D sired gilts and 207 L sired gilts were studied. The second year 521 DxL F2 gilts were studied. To provide insight into the mechanism of fat accumulation and endocrine effects,

serum leptin concentrations were measured by RIA at puberty. Sire line effects were NS in relation to age of puberty, BW, BF, and leptin concentrations. However, significant sire effects were noted in all traits measured. Frequency analysis showed that leptin concentrations were greatest ($P < 0.01$) when the majority of animals attained puberty (196 ± 1.2 days of age). Gilts with delayed puberty (>230 days of age, mean age of puberty ± 1 SD) had increased BW ($P < 0.01$) and BF but decreased ($P < 0.01$) leptin concentrations. Incidence of delayed puberty was 31% in D sired gilts, 32% in L sired gilts and 20% in the D x L F2 gilts. Gilts with delayed puberty had sufficient BW and BF but low leptin levels suggesting delayed puberty in these gilts may be a result of gilts still being in a perceived growth phase of development and/or have a deficiency in leptin secretion. Identification of the genetic component associated with the low leptin levels/delayed puberty would provide a management tool to identify gilts that have attained market weight but will not produce a litter by a year of age.

Key Words: Leptin, Puberty, Growth

239 Blood biochemical and hematological profiles of beef steers to repeated social regrouping and relocation. S. Gupta^{1,2}, B. Earley^{*1}, S. Ting^{1,2}, and M. Crowe², ¹*Teagasc, Grange Research Centre*, ²*Faculty of Veterinary Medicine, Ireland*.

To investigate the effect of repeated regrouping and relocation (MIX) on the blood biochemistry, hematological profiles and average weight gain (ADG), 72 Holstein-Friesian (14-mo-old; 441 ± 3.2 kg) steers were randomly assigned to either control (n=30; C) or regrouped (n=42; R) treatments and housed 6 per pen in 12 pens. The R steers were exposed to 6 MIX over 102 d. New pen cohorts were allowed to stabilize for 14 d. None of the R steers were allowed to share the same pen or pen-mates where or with whom they were previously housed. C steers were housed in the same pen with the same pen-mates. Blood samples were collected 2 h before and 2 h after MIX 1, 3 and 6. Steers were weighed before each MIX. Albumin, urea and non-esterified fatty acids (NEFA) were higher ($P \leq .05$) in R than C steers after MIX 1, with no differences in C vs R after MIX 3 and 6. Beta-hydroxybutyrate (BHB), protein, globulin and glucose were not different ($P \geq .05$) after MIX 1 and 3 in C vs R. BHB and glucose levels were higher ($P \leq .05$) in R than C, while no ($P \geq .05$) changes in the protein and globulin levels were found in C vs R after MIX 6. Administration of dexamethasone ($20 \mu\text{g}/\text{kg}$ BW at -12h) increased ($P \leq .05$) albumin, urea, globulin and NEFA after MIX 3 in C steers, while glucose and NEFA were increased ($P \leq .05$) in R steers after MIX 3 and 6. White blood cell (WBC) differential and total count, red blood cell (RBC) and platelets numbers were not different ($P \geq .05$) in C vs R after MIX 1 and 3. Lymphocyte numbers and mean corpuscular volume (MCV) were higher ($P \leq .05$) in R than C steers after MIX 6. Dexamethasone injection increased ($P \leq .05$) lymphocyte and monocyte numbers in C and in R after MIX 3 and 6, while RBC and WBC were increased ($P \leq .05$) in R vs C after MIX 6. There was no ($P \geq .05$) difference in the overall ADG in C vs R. In conclusion, steers responded to MIX by increasing metabolic activity. However, there was metabolic adaptation over time among steers repeatedly exposed to regrouping and relocation.

Key Words: Physiology, Mixing, Steers

240 Folate binding protein is secreted by porcine endometrium until placentation in pigs. J. G. Kim^{*} and J. L. Vallet, *USDA, ARS, US Meat Animal Research Center*.

Porcine endometrium secretes folate binding protein (FBP) into the lumen, which is likely involved in folate transport to the developing conceptus. FBP secretion up to D 15 of pregnancy has been reported, but the cellular origin of the FBP and secretion during later pregnancy has not been studied. Thus, the objective of this study was to determine the endometrial localization of the FBP by immunohistochemistry throughout pregnancy. A portion of the uterine walls were collected from D 10, 13 and 15 cyclic and D 10, 13, 15, 20, 35, 50, 70, 90 and 105 pregnant White composite gilts (n=3 to 5) and fixed with 4% paraformaldehyde in PBS. After 16 h, fixed tissues were washed with PBS, changed to 70% (v/v) ethanol, dehydrated through a graded series of ethanol concentrations, and embedded in paraffin. Uterine wall sections (6 μm) were deparaffinized in xylene and rehydrated to water through a graded series of ethanol concentrations. Antigenic sites were revealed by heating the sections in 50 mM Tris, 0.1% SDS and 1% β -mercaptoethanol. Sections

were then incubated with buffer (50 mM Tris, 0.5 M NaCl and 1% Triton X-100) containing 100 $\mu\text{g}/\text{ml}$ of either rabbit anti-porcine FBP IgG or normal rabbit serum IgG (both purified using protein A). Localization of bound antibody was determined using the Vectastain Elite ABC reagent with DAB as chromogen. Tissue sections were then counterstained with hematoxylin. In cyclic gilts, immunohistochemical staining of the FBP was present in the endometrial glands on D 10, appeared to be more intense on D 13, and appeared to decrease by D 15. In pregnant gilts, staining was present in the glandular epithelial cells on D 13, 15, and 20, and was absent after D 20. This pattern of FBP staining is consistent with the concept that the secreted form of FBP transports folate to the developing conceptus until the placenta is formed sometime between D 20 and 35 of pregnancy.

Key Words: Pregnancy, Glandular Epithelium, Conceptus Development

241 Effect of decreased estradiol-17 β on the IGF system in pigs. C. Hilleson-Gayne^{*} and J. A. Clapper, *South Dakota State University Department of Animal & Range Sciences*.

Administration of estradiol-17 β (E2) to barrows has been shown to increase anterior pituitary (AP) concentrations of IGF-I, but boars still had greater relative amounts of AP IGF-binding protein-2 (IGFBP) and -5. To determine the effect of decreased levels of E2 on the serum and AP IGF system, 24 crossbred boars and 12 barrows of similar age (110 d) and weight (44 kg) were stratified by litter to one of three treatment groups (n=12) on day 0. Treatment groups consisted of boars administered 10 mg of an aromatase inhibitor, anastrozole, daily (A), boars administered 0 mg daily (B), and barrows (BAR). Pigs were penned separately and received ad libitum access to water and fed a diet daily that contained 2.5 fold the energy requirements for maintenance. Pigs were bled and weighed on d 0 and every two weeks thereafter, then killed on d 84 when a blood sample and AP were collected. Serum concentrations of E2, testosterone (T), IGF-I, and AP concentrations of IGF-I and LH were determined by RIA. Relative amounts of serum and AP IGFBP were determined by Western ligand blot analysis. Mean serum concentrations of E2 did not differ ($P > .05$) between A and B pigs on d 0; however, on d 15 through d 84 mean serum concentrations of E2 were greater ($P < .05$) in B than A pigs. Mean serum concentrations of T did not differ ($P > .05$) between B and A pigs until d 84 when mean serum concentrations of T were greater ($P < .01$) in B than A pigs. On d 0, 15, 43, mean serum concentrations of IGF-I were greater ($P < .05$) in A than B pigs, and each was greater ($P < .05$) than BAR throughout. Mean AP concentrations of LH and IGF-I did not differ ($P > .05$) in B and A pigs, but each was greater ($P < .01$) than BAR. Mean relative amounts of IGFBP-3 in serum did not differ ($P > .05$) in B and A pigs, but each was greater ($P < .01$) than BAR. Mean relative amounts of the 24 kDa form of IGFBP-4 in serum were greater ($P < .01$) in A than B and BAR pigs, but B pigs and BAR did not differ ($P > .05$). Mean relative amounts of AP IGFBP-2 and -5 were less ($P < .01$) in A than B pigs, but each was greater ($P < .01$) than BAR. These data further support a role for E2 in regulating components of the IGF system in pigs

Key Words: Estradiol, IGF, Binding Proteins

242 Effect of HEPES-buffered NCSU23 and straw on in vivo viability of in vivo derived porcine embryos. B. S. Yang^{*1,2}, J. N. Caamano¹, M. Katayama¹, A. R. Rieke¹, R. Farwell¹, T. C. Cantley¹, C. Murphy¹, and B. N. Day¹, ¹*University of Missouri-Columbia*, ²*National Livestock Research Institute*.

Recent advances in non-surgical embryo transfer in swine will require a practical culture system that could be used under field conditions. According to our preliminary results, porcine embryos could develop in HEPES-buffered NCSU23 in straw. The objective of this study was to assess the effect of HEPES-buffered NCSU23 medium and 0.25ml straw on viability following transfer of in vivo derived porcine embryos. Embryos were collected surgically on day 3.5-5.5 after onset of estrus and were randomly divided into 4 groups; NCSU23 in 4-well dish (N-W), NCSU23 in 0.25ml straw (N-S), HEPES-buffered NCSU23 in 4-well dish (H-W) and HEPES-buffered NCSU23 in 0.25ml straw (H-S). Embryos in all groups were cultured using modular incubator chambers which were placed in non-CO₂ incubator at 38.5C for 48 hr. Modular chambers in N-W and N-S groups were flushed with 5% CO₂ in air for 4 min. Cultured embryos (13-23) were transferred surgically to recipient gilts that had shown estrus 1 day after the donor or synchronized with the

donor. Pregnancy diagnosis was performed 25-30 days after onset of estrus by ultrasound. Data were analyzed using SAS-Fisher's Exact Test. In groups cultured in 4-well dish, all stages of embryos (4 cell to morula) developed to morula or blastocysts after 48 hr culture. Also, 72.2 and 90.6% of 4-cell embryos ($P < 0.05$), 85.7 and 77.4% of 8-cell embryos ($P < 0.05$), and all morulae in N-S and H-S groups developed to morula or blastocysts, respectively. A total of 15 transfers was performed and 9 pregnancies were obtained (60%). The pregnancy rate in N-W, N-S, H-W and H-S was 100%(2/2), 60%(3/5), 50%(2/4), and 50%(2/4), respectively ($P > 0.58$). When the pregnancy rate was analyzed by initial culture stage placed in straws, the pregnancy rate of cultured morulae was higher than in cultured 4 to 8-cell embryos. These results indicate that porcine embryos can develop in 0.25ml straws in HEPES-buffered NCSU23 without CO₂ atmosphere, and that development of early stage embryos was affected by the different culture systems used.

Key Words: Porcine, Embryos, Viability

243 The relationship between porcine uterine and placental IGF-I, IGF-II, IGFBP-3, AND IGFBP-5 messenger rNA (mRNA) levels at mid-gestation. J. P. Kayser*¹, A. T. Waylan², and B. J. Johnson², ¹USDA, ARS, U.S. Meat Animal Research Center, ²Animal Science and Industry, Kansas State University.

This study investigated the relative gene expression of IGF-I, IGF-II, IGFBP3 and IGFBP-5 in the placenta and uterus in fourth-parity sows ($n=12$). At approximately mid-gestation (d 54 to 59), bilateral hysterectomies were performed. From each horn, the median fetus was selected and removed along with the excision of uterine and attached chorioallantoic placenta tissues. Uterine and placental IGF-I, IGF-II, IGFBP-3, and IGFBP-5 mRNA levels were measured using real-time quantitative-rtPCR. The correlations between fetal growth traits and reproductive tissue mRNA levels were analyzed. Neither fetal weight nor fetal length was correlated ($P>0.05$) with placental IGF-I, IGF-II, IGFBP-3, or IGFBP-5. However, uterine IGFBP-3 was negatively correlated ($P<0.05$) to the number of fetuses per uterine horn (-0.56), fetal weight (-0.52) and fetal length (-0.58). Similarly, fetal weight and length were negatively associated with ($P<0.05$) uterine IGF-II mRNA levels (-0.52 and 0.61, respectively). Uterine IGF-I and IGFBP-5 mRNA levels were not associated with ($P>0.05$) fetal size. The IGF-II mRNA levels were 3,438-fold higher than IGF-I levels (357.7 ± 51.1 to 0.104 ± 0.017) in placenta compared to a 14.2-fold difference (21.6 ± 6.28 to 1.52 ± 0.311) in the uterus. A similar trend was found between IGFBP-3 and 5 mRNA levels with a 17.5-fold difference (24.60 ± 5.45 to 1.40 ± 0.363) in placental tissue and a 4.2-fold difference (15.24 ± 3.06 to 3.63 ± 0.996) in uterine tissue. Relative abundance of placental IGF-II mRNA was 16.5-fold higher than the relative abundance of uterine IGF-II mRNA. Conversely, relative IGF-I mRNA levels were 14.7-fold more abundant in the uterus than placenta. There were no ($P>0.05$) correlations between uterine and placental mRNA levels of IGF-I, IGF-II, or IGFBP-3. These results suggest that placental and uterine IGF genes are regulated independently and thus may perform autonomous roles at mid-gestation.

Key Words: IGF, Placenta, Uterus

244 Dental disease and culling in sows. E. W. Johnson*, S. E. Curtis, and M. Ellis, *University of Illinois*.

As reported (Proc 2003 Leman Swine Conference 30(Suppl):28) we studied 82 mature heads at 2 sow abattoirs. Significant lesions were: molar wear in 63% of sows; incisor wear 62% and loss 34%; 1 or more of preceding 85%; gingivitis 55%; retained deciduous incisors 15%; abscessation 4%. Calculus/gingivitis was associated with gumline recession, often with abscessation/tooth loss. Other problems (total 4%) were hair/herbage between tooth/gum; abraded/lacerated/ulcerated gums/lips/cheeks; malocclusion. Some lacerations were associated with broken/sharp/jagged incisors, molars having sharp edges. Abscessation occurred in periodontal pockets. Malocclusion seemed to result from brachygnathia/rostral distortion due to AR/genetics. Mature sows (≥ 18 mo) ($n=82$) had more lesions than immature ($n=32$) (85% vs 41%, $P<.01$). Abscesses yielded anaerobic and pyogenic bacteria. We also studied live sows in 3 herds (A, B, C) at 4 farms (2 indoor [A_N, B_N], 2 out- [B_O, C]). There were differences between indoor and outdoor herds; e.g., significant incisor wear occurred in 47% of indoor sows, 5% of outdoor ($P<.01$). Molar wear primarily involved P₄ and M₁ (first to erupt

[5-6 mo]) teeth. Broken/worn teeth are painful as evidenced by sow reactions to probing. So dental disease probably has negative impact on sow state of being, nutritional status, performance, longevity. To further investigate this postulate we evaluated oral condition in 53 sows of parity 1 to 10 in a commercial herd. Culling data were examined over the following 4.5 mo. Annualized cull rate for the 53 sows that period was 37%. Of sows with bad molars, 63% were culled, whereas only 5% of sows with good molars were culled ($P<.01$) The bad-molar effect per se held despite its being confounded with age. Some 47% of sampled sows were "old"; i.e., at parity ≥ 5 ($n=25$) (typical of the herd [χ^2 , $P=.85$]). Of these old sows, 30% were culled as opposed to only 4% of sows not old ($P<.01$). However, sows with bad molars were $>17\times$ as likely to be culled as sows with normal molars ($P<.01$). When corrected for covariance in age, sows with bad molars were still $>9\times$ as likely to be culled ($P<.05$)

Key Words: Sow, Dental, Culling

245 Effect of altering dose of PG600 for improving reproductive performance of prepubertal gilts and weaned sows. S. M. Breen*, K. M. Ruggiero, K. L. Farris, and R. V. Knox, *Department of Animal Sciences, University of Illinois*.

PG600 has been shown to be effective for inducing estrus in prepubertal gilts and weaned sows. However, the response in gilts is far below optimal, and in sows there is no increase in farrowing rate. It is unclear whether altering the dosage can improve these measures for either gilts or sows. In experiment 1, the effect of increasing the dose of PG600 from 1X (400 IU eCG + 200 IU hCG), to 1.5X (600 IU eCG + 300 IU hCG) and to 2X (800 IU eCG + 400 IU hCG) was evaluated in 175 d old gilts ($n = 227$). Estrus and ovulation was recorded following administration in a single 2 mL injection. The percentage of gilts showing estrus (50 %) and ovulating (86 %) within 7 d was not affected by dose, but did influence ovulation rate (17, 24, and 25 CL) and incidence of cysts (36, 39, and 50 % for the 1X, 1.5X, and 2X doses, respectively). Experiment 2 evaluated the effect of 0X, 0.5X (200 IU eCG + 100 IU hCG), 1X, and 1.5X doses of PG600 on estrus, farrowing, and litter size when given to sows ($n = 122$) in a single 2 mL injection at weaning. Estrus (87, 97, 98, 76 %) within 7 d of PG600 was not influenced, but the number of large follicles at estrus was increased by dose (17, 19, 24, 26) for the 0X, 0.5X, 1X, and 1.5X doses respectively. Dose influenced cysts, and cysts were increased for the 1.5X dose compared to the lower doses (range: 2-6 %). Farrowing rate was increased ($P \leq 0.05$) with 0.5X compared to 0X and 1.5X (82 and 72 %, respectively) but was similar to the 1X (76 %). Number of total born pigs was similar across all treatments (10.2). These data suggest that for prepubertal gilts, increasing the dose to 1.5X could improve ovulation rate without increasing cysts, which could prove beneficial for oocyte or embryo collection efficiency. For weaned sows, the 0.5X was similar to the 1X for estrus induction, but improved farrowing rate when compared to controls, while higher doses did not improve reproductive performance. Further research is required to determine if lower doses improve farrowing rates for weaned sows in field trials.

Key Words: Estrus, Gonadotropins, Ovulation

246 Programmed one- or two-day shifts in estrus cycles of gilts using prostaglandin (PGF_{2α}) to induce luteolysis. T. L. Brancel*, M. E. Glenn, T. P. Dybevik, and T. D. Crenshaw, *University of Wisconsin*.

Seventy cycling gilts (age 7 to 8 mo) were used to determine if PGF_{2α} (Lutalyse[®], Pharmacia & Upjohn Co.) could be used to program a 1- or 2-d shift in the estrus cycle in order to meet surgery schedules for embryo transfers. The pig corpora lutea acquires luteolytic capacity near day 13 of the estrus cycle. Cycling gilts were injected 1 or 2 days with 25 mg PGF_{2α} /d or saline (2 ml) on selected days to shift estrous to a fixed weekday (Thur and Fri) surgery appointment. Four treatment groups were used over a 3-mo period and were checked daily for estrous using fence-line contact with a boar. Gilts cycling on Mon were injected on day 12 after estrous with PGF_{2α} (T1) or if estrous occurred on Tues or Wed gilts were injected on day 12 and 13 each with PGF_{2α} (T2). Gilts cycling on Thur, Fri, Sat, or Sun were injected with saline (T3) on day 14 or served as non-injected controls (T4). Over the 3-mo trial, 166 estrus cycles were analyzed to determine treatment responses, 24 cycles were deleted as non-estrous or missed (no detection >35 d), 27

gilts were removed for surgery, 1 was sold because of lameness, and 12 new gilts were introduced into the pool. The non-estrous cycles were distributed equally across treatment groups with 14.7, 10.4, 16.4 and 17.3% incidence for T1 to T4 respectively. Based on 34, 48, 61 and 23 estrus cycles for T1 to T4 groups respectively, average cycle periods were 19.1, 18.1, 20.2 and 20.5 d (pooled SEM = 0.24) for T1 to T4 groups. One injection with PGF_{2α} on day 13 decreased (P<0.01) the estrus cycle by 1 day while two injections with PGF_{2α} starting on day 12 decreased the estrus cycle by 2 days compared with gilts given saline injections or no injection. In conclusion, PGF_{2α} induction of luteolysis can be used in a management scheme to program a one or two day shift in the estrus cycle. This approach may be useful in other strategies as a method to program consistent weekly labor and animal management schedules.

Key Words: Swine, Luteolysis, Embryo Transfer

247 Model for evaluation of testicular development in boars. J. J. Ford*, D. D. Lunstra, T. H. Wise, and G. A. Rohrer, *USDA, ARS, US Meat Animal Research Center.*

Sperm production of boars is positively associated with testicular wt. A QTL for testis size on chromosome X was identified in a line of one-half Meishan crossbred pigs. This line was mated to Landrace x Yorkshire crossbreds followed by three generations of inter se mating. Sixteen gilts, heterozygous for the testis-size QTL, were selected from the third generation and mated to produce littermate boars to investigate testis size. Boars from one-half of these litters were unilaterally castrated at 25 d of age, and the remaining litters were unilaterally castrated at 56 d to relate early Sertoli cell development to subsequent testicular size. At 10 mo of age the remaining testis was removed and weighed; boars within litters were classified as having the smallest (SM, n=13), largest (LR, n=13) or intermediate testis wt (IN, n=22) yielding mean testis wt of 312, 419 and 579 g for SM, IN and LR boars, respectively. Birth wt was less for SM than LR boars (P<0.01, 1.14 vs 1.34 kg). Body wt at 10 mo remained different for these two groups (P<0.01; 136 vs 149 kg) with IN boars being intermediate. Plasma FSH at 4 and 10 mo and TSH at 4 mo were negatively correlated with testis wt at 10 mo (P<0.05); IN boars were intermediate for both plasma FSH and TSH. Seminiferous tubule diameter of boars unilaterally castrated at 25 d was similar for SM, IN, and LR boars but was greater (P<0.01) at 56 d in SM than in LR boars. Color of testis at 10 mo was darker in SM than in LR boars with IN boars being intermediate. The QTL for small testes was in 9/13 SM, 11/22 IN, and 2/13 LR boars indicating that this X-chromosome QTL influences testis size, but factors other than genes associated with this QTL also impact testicular development. Gilts that were heterogeneous for the testis-size QTL produced littermate boars that varied significantly in testis wt. Boars that ultimately developed small testes had greater FSH secretion and earlier pubertal development than boars that developed large testes. This model will be useful to investigate factors that regulate testis development.

Key Words: Testis, FSH, QTL

248 15-Lipoxygenase as a semen quality marker in boars. K. W. Lovercamp*¹, T. J. Safranski¹, K. A. Fischer¹, G. Manandhar¹, M. Sutovsky¹, W. O. Herring², and P. Sutovsky^{1,3}, ¹*Department of Animal Sciences, University of Missouri*, ²*Smithfield Premium Genetics Group*, ³*Obstetrics and Gynecology, University of Missouri.*

Farm animal semen evaluation techniques lack the ability to identify subfertile males that produce morphologically acceptable ejaculates. A common cause of boar ejaculates being unfit for use in artificial insemination is the retention of the sperm cytoplasmic droplet (CD) or the presence of shed CDs within the ejaculate. We identified the arachidonate 15-Lipoxygenase (15-LOX) as one of the major enzymes within porcine sperm CD and conducted a study to evaluate the possibility of using 15-LOX as a fertility marker for boars. Immunoreactivity to antibodies against 15-LOX were used to indicate relative amount of the CDs within an ejaculate regardless of whether or not they were associated with spermatozoa. Evaluation of semen 15-LOX-content was performed by western blot using enhanced chemiluminescence, producing a single immunoreactive band of 75 kDa attributable to 15-LOX. Anti-LOX antibodies were raised against the C-terminus amino acid sequence (YLRPSIVENSVAI) of rabbit erythrocyte 15-LOX. Quantification of

15-LOX immuno-reactivity was performed using computerized densitometry. Ejaculates were collected from 12 individual boars in April (n=12) and August (n=11). There was no significant correlation (r=-0.0175) between April LOX content and August LOX content. Nine of the twelve boars were used for breeding and farrowing rates (FR) collected. Number of sows bred per boar ranged from 3 to 38. There was a negative correlation (r=-0.6635; P < 0.10) for April LOX content with FR from matings one month prior and one month following LOX evaluation (mean FR 70%; range 36-100%). This indicates that as 15-LOX content increases, there is a corresponding decrease in farrowing rate. Farrowing rates for August matings are not yet available. These data provide an indication that 15-LOX could be a fertility marker for boars.

Key Words: 15-Lipoxygenase, Cytoplasmic Droplet, Boar

249 Effects of exogenous ghrelin on feed intake, weight gain, behavior, and endocrine parameters in weanling pigs. B. E. Salfen*¹, J. A. Carroll¹, D. H. Keisler², and T. A. Strauch¹, ¹*Animal Physiology Research Unit, Agricultural Research Service-USDA*, ²*University of Missouri.*

The objectives were to determine relative gain, feed intake, behavior, and endocrine parameters in weaned pigs receiving exogenous ghrelin. Twenty-four barrows weaned at 18 d of age (d 0 of study), were jugular vein catheterized, weighed, and assigned to either a ghrelin (GR; n=12) or saline (CON; n=12) injection group. Initial pig weights were not different between treatments (7.87 ± 0.39 vs. 7.92 ± 0.35 kg for GR and CON treatments, respectively). Pig weights and feed intakes were measured once daily throughout the study. Starting on d 1, GR pigs were intravenously injected three times daily for 5 d with 2 µg/kg human ghrelin and CON pigs were similarly injected with saline. Activity observations and blood samples were taken at -15, 0, 15, 30, 60, 90, 120, 240, and 480 min relative to the first injection and then three times daily (0800, 1600, and 2400 h) for 8 d. Weight gain during the 5 d injection period was greater in the GR-treated compared to CON-treated pigs (0.57 ± 0.10 vs. 0.21 ± 0.13 kg, respectively; P < 0.04), however there was no increase in feed intake. Two observation periods during the experiment showed more pigs in the GR treatment eating during the observation period compared to CON-treated pigs (P < 0.05). The initial injection of exogenous ghrelin elevated serum ghrelin, GH, insulin, and cortisol (P < 0.05). Endogenous serum ghrelin increased from d 1 to 8 of the study in CON animals (P < 0.05). Serum IGF-I initially fell in both treatment groups from d 1 to 2 (P < 0.05), but then increased from d 5 to 8 (P < 0.05). Peripheral concentrations of glucose in the GR-treated pigs were greater on d 2, 3, 7, and 8 than on d 1 (P ≤ 0.05). In both treatment groups, peripheral concentrations of leptin increased from d 7 to 8 and cortisol decreased from d 1 to 5 of the study. These observations provide evidence that ghrelin may positively influence weight gain, while concomitantly increasing GH, insulin, and cortisol secretion in weaned pigs.

Key Words: Ghrelin, Feed Intake, Weaning

250 Modification of conceptus development by growth hormone treatment of ewes at breeding. B. A. Costine* and M. E. Wilson, *West Virginia University.*

Treatment of ewes with growth hormone (GH) at breeding has previously been shown to result in increased uterine luminal concentrations of IGF-I on day 7 of pregnancy and larger lambs at birth, 30 and 60 days of age. Fetal growth is limited by the ability of placenta to transport nutrients to the fetus from the dam. The placenta that develops during early pregnancy allows for rapid fetal growth that occurs during the last third of gestation. In sows, treatment with estrogen on days 11 and 12 of pregnancy has been shown to increase placental size and decrease placental efficiency (fetal weight/placental weight) at term. The objective of this experiment was to examine if GH treatment altered conceptus development at days 25, 80 and 140 of gestation. At breeding, ewes (n = 48) received either an injection of long acting GH (500 mg, Posilac) or served as controls. There was no effect of treatment on conceptus characteristics on day 25 of gestation. On day 80, GH-treated ewes had reduced chorioallantoic weight (169 ± 63 g vs. 505 ± 146 g, P < 0.05), tended to have placental weights composed of a higher percentage of cotyledons (77.2 ± 2.3% vs. 57.6 ± 1.0%; P = 0.068), and tended to have more efficient placentae (fetal weight/ chorioallantoic weight; 2.78 ± 0.2 vs. 1.28 ± 0.18; P = 0.05) compared to conceptuses gestated

in non-treated ewes. In non-treated ewes, placental weight at term was achieved by day 80 of pregnancy, whereas in GH-treated ewes, placentae continued to increase in weight from day 80 until day 140 when placental weight was not different between treatments. There was no effect of treatment on fetal weight, but conceptuses from single pregnancies had heavier placentae (865 ± 434 g vs. 591 ± 215 g, $P < 0.05$) and tended to have larger fetuses (2.2 ± 0.4 kg vs. 1.4 ± 0.4 kg; $P = 0.057$) than

conceptuses from multiple pregnancies. Treatment of ewes with GH at breeding results in modified placental development, which may allow for larger weights at birth and during postnatal growth. This work was supported by USDA-NRICGP Proposal #2001-35203-10982.

Key Words: Placenta, Growth Hormone, Ewe

Ruminant Nutrition

251 A procedure for preparation and quantitative analysis of samples for titanium dioxide. V. Nayigihugu*, W. D. Myers, P. A. Ludden, and B. W. Hess, *University of Wyoming*.

A procedure was developed for the rapid analysis of titanium dioxide (TiO_2) concentrations in feed and fecal samples. Samples were digested in concentrated H_2SO_4 for 2 h, followed by addition of 30% H_2O_2 , and absorbance was measured at 410 nm. Standards were prepared by spiking blanks with increasing amounts of TiO_2 , resulting in a linear standard curve. Complete analysis using this procedure was accomplished within 4.5 h. This procedure was compared to a previously published dry-ash procedure for the analysis of TiO_2 in forage and bovine fecal samples. Three sources of OM devoid of TiO_2 (a forage sample, a bovine fecal sample without Cr_2O_3 , and a bovine fecal sample containing Cr_2O_3) were spiked with graded amounts (0, 2, 4, 6, 8, or 10 mg) of TiO_2 . With our procedure, TiO_2 recoveries averaged 96.7, 97.5, and 98.5%, for the 3 OM sources, respectively, versus 74.3, 83.8, and 53.1% for the same samples analyzed using the dry-ash method. These results suggest that the current procedure is a rapid and accurate alternative to dry-ash procedures for the determination of TiO_2 .

Key Words: Analytical Procedure, Markers, Titanium Dioxide

252 Fecal excretion patterns of titanium dioxide versus chromic oxide in ewes fed diets varying in level of forage. W. D. Myers, R. L. Atkinson, P. A. Ludden*, V. Nayigihugu, and B. W. Hess, *University of Wyoming*.

Three experiments were conducted to compare fecal excretion patterns of TiO_2 and Cr_2O_3 in an effort to evaluate appropriate fecal sampling protocols. In Exp. 1, eight ruminally cannulated ewes (74.7 ± 2.9 kg) were fed 100% long-stem bromegrass hay for ad libitum consumption, and dosed intraruminally at each feeding with gelatin boluses containing 2.5 g Cr_2O_3 and 2.5 g TiO_2 . After 8 d of adaptation, fecal grab samples were collected at 6-h intervals for 6 d, with collection times advanced 1 h each d to represent every 1-h interval in a theoretical 24-h clock. Exp. 2 and 3 were conducted using the same protocol, except that ewes were fed basal diets consisting of a 50:50 or 25:75 mixture of bromegrass hay and corn-based concentrate, respectively. No marker \times time interactions were observed ($P > 0.55$) in any of the three experiments. Irrespective of diet fed, TiO_2 concentrations were higher ($P < 0.02$) than Cr_2O_3 at almost every sampling time. Although fecal marker excretion patterns were not affected ($P = 0.13$) by sampling time in Exp. 1, significant ($P < 0.001$) time effects were observed in Exp. 2 and 3. Nonetheless, simulating a decrease in frequency of fecal sample collection to intervals up to 12 h did not affect ($P > 0.16$) mean marker concentrations for either marker in Exp 1 or 2, or for TiO_2 in Exp. 3. However, mean Cr_2O_3 concentrations were lower ($P < 0.04$) when sampling intervals greater than every 2 h versus every 1 h of a theoretical 24-h clock were examined. Although differences in mean concentrations of TiO_2 and Cr_2O_3 may exist, the lack of significant marker \times time interactions in fecal marker excretion suggests that TiO_2 behaves similarly to Cr_2O_3 as a marker of fecal output. As such, the frequency with which fecal samples are collected may be reduced without markedly affecting estimates of digestibility, particularly when diets containing higher amounts of forage are fed.

Key Words: Titanium Dioxide, Chromic Oxide, Fecal Excretion

253 Evaluation of the variability in urinary creatinine and purine derivative excretion in growing and finishing heifers. K. M. Whittet*, T. J. Klopfenstein, G. E. Erickson, T. W. Loy, R. A. McDonald, and K. W. Creighton, *University of Nebraska*.

The use of creatinine as a reference material to predict output of metabolites requires uniform and constant excretion in urine or a means of accounting for known variation. Urinary creatinine (Cr) and purine derivative (PD) excretion were studied in growing and finishing heifers to evaluate animal and daily variation. Total urine was collected with indwelling Foley catheters for 5 consecutive days for two collection periods. In period 1, nine heifers (BW = 403 ± 27 kg) were fed a forage diet supplemented with dried distillers' grains (HAY). In period 2, seven of the heifers (BW = 494 ± 22 kg) were fed a finishing diet (90% concentrate:10% forage; FIN). All animals were fed once daily at 0800 in individual stanchions at 2.0% of BW. Urine was composited by animal within day and analyzed for Cr and PD (allantoin plus uric acid) concentration using HPLC. While urinary Cr (g/d) and PD (mmol/d) excretion were different ($P = 0.07$) among animals fed HAY, Cr excretion was not different ($P = 0.39$) among animals when expressed as a coefficient of BW (mg/kg BW). The PD to Cr ratio (PD:Cr) was also similar ($P = 0.71$) among animals fed HAY. No differences in Cr ($P = 0.18$) and PD ($P = 0.35$) excretion were found among animals fed FIN. The PD:Cr was different ($P < 0.01$) among animals fed FIN. Urinary Cr (g/d and mg/kg BW) was not different ($P = 0.42$) across the 5-d collection for animals fed HAY. Purine derivative excretion (mmol/d) increased quadratically ($P = 0.02$) across sampling days, yet there was no difference in PD:Cr ($P = 0.72$). Creatinine and PD excretion increased linearly ($P < 0.01$) for animals fed FIN from d 1 to 5. However, PD:Cr remained constant ($P = 0.18$) over experimental period days, stabilizing variability seen in individual PD and Cr components. While heifers responded differently to diet, Cr excretion was relatively constant among animals and PD:Cr remained constant across experimental period days. Creatinine may be a useful index material for urinary PD excretion.

Key Words: Beef Cattle, Creatinine, Purine Derivatives

254 Utility of near infrared reflectance spectroscopy to predict nutritional components in total mixed rations. R. L. Mentink, P. C. Hoffman, and L. M. Bauman, *University of Wisconsin*.

Total mixed ration (TMR) samples ($n = 110$) were collected from submissions to the Marshfield Soil and Forage Laboratory, Marshfield, WI. Samples were dried and ground for chemical, in situ, in vitro, and near infrared spectroscopy (NIRS) determinations. The TMRs were evaluated for CP, soluble CP, NDF CP, NDF, starch, total (80%) ethanol-soluble carbohydrate (TESC), fat, and ash. The non-fiber carbohydrate (NFC) content of TMR samples was calculated (NRC, 2001). In situ, A = rapidly degraded, B = slowly degraded, and C = undegraded CP fractions were determined on TMRs using duplicate 50 μm dacron bags filled with 5 g of dried ground TMR, incubated in the ventral rumen of two cows fit with rumen cannula. The TMR samples were also evaluated for 48 h in vitro DM, OM, and NDF digestibility. The TDN and NE_L contents of TMRs were estimated using summative equations (NRC, 2001). The TMRs were scanned on a Model 6500 near infrared reflectance spectrophotometer and spectra retained. Calibrations and cross-validations were made using Infrasoft International software (Version 2). Math transformations and number of model terms was varied to yield the best calibration for each TMR nutrient. The NIRS cross validations (r^2) for CP, soluble CP, NDF CP, NDF, starch, TESC, fat, ash, and NFC were 0.87, 0.70, 0.44, 0.90, 0.89, 0.61, 0.81, 0.77, and 0.83, respectively. Data suggest CP, NDF, and starch in TMRs were well predicted by NIRS while other nutrients predictions were less accurate. The A, B, and C in situ CP fractions in TMRs were not well predicted by NIRS with standard errors of prediction (SEP) of 5.1, 5.2,

and 1.7% of CP, respectively. In vitro digestible DM and OM were predicted adequately ($r^2 = 0.85$ and 0.80) but in vitro NDF digestibility in TMRs was not well predicted ($r^2 = 0.59$) by NIRS. Summative TDN and NE_L of TMRs was predictable by NIRS with cross validation coefficients (r^2) of 0.87 and 0.87 and SEP of 1.5% of DM and 0.02 Mcals/kg, respectively. Data suggest NIRS is well suited to predict some but not all nutrients in TMRs.

Key Words: Total Mixed Ration, NIR, In Situ

255 Influence of substrate and buffer pH on fiber digestion kinetics in vitro. S. G. Escue*, M. L. Bauer, G. P. Lardy, and S. A. Soto-Navarro, North Dakota State University.

The objectives of this study were to determine rate and extent of DM, NDF, and ADF disappearance, and estimate ruminal degradability of various fiber sources when fermented in vitro. Delivery of fiber to the hindgut may have potential to reduce NH_3 emissions from feedlot cattle by promoting hindgut fermentation and increasing OM content of manure. Substrates included barley malt pellets (BM), beet pulp (BP), confection sunflower hulls (CSH), corn bran (CB), oil sunflower hulls (OSH), soy hulls (SH), and straw (S). The experiment was replicated twice. Two phosphate-bicarbonate buffers were used (pH 5.8 and 6.8; adjusted with 1 M citric acid). Duplicate samples (0.25 g; 1mm grind) were placed into Ankom fiber bags in Ankom Daisy incubators with buffer and rumen fluid (4:1) for 24, 48, and 96 h. Ruminal fluid was obtained from two steers fed a 90% concentrate corn-based diet. Upon removal, samples were rinsed and frozen until fiber analysis. NDF and ADF were determined by Ankom procedures. Data was analyzed by SAS, using non-linear regression (Marquardt option) and GLM. Data were fitted to model where percent disappearance = potentially digestible material $\cdot (1 - e^{-Kt})$. No pH by substrate interactions were found. Substrate affected rate ($P = 0.003$) of DM disappearance, and extent ($P < 0.001$) of DM, NDF, and ADF disappearance. Lowered pH decreased rate of DM disappearance ($P = 0.02$), and increased extent of disappearance for NDF ($P = 0.05$) and ADF ($P = 0.03$). Estimated ruminal degradations of DM, NDF, and ADF were lowest for CSH and highest for BP ($P < 0.001$). Ruminal degradation estimates of DM ($P = 0.04$) and ADF ($P = 0.02$) decreased with decreasing pH. When ruminal pH nears 5.8, as on high grain diets, DM and fiber digestion may be significantly decreased, allowing fiber to enter the hindgut. Fiber and DM that bypass the rumen may be fermented in the hindgut or may leave the animal intact (increasing fecal OM); potentially lowering NH_3 emissions from manure.

Substrate influence on rate and extent of DM and fiber disappearance.

Item	Substrate							
	BM	BP	CB	CSH	OSH	S	SH	SE
Rate (%/h)								
DM	8.02 ^{ab}	7.30 ^{ab}	2.78 ^a	7.39 ^{ab}	10.80 ^b	3.07 ^a	5.41 ^a	0.012
NDF	1.37	4.80	1.90	8.03	5.76	1.96	3.07	0.016
ADF	0.39	3.55	1.78	2.19	6.10	2.72	2.77	0.012
Extent (%)								
DM	76.4 ^d	92.5 ^e	87.0 ^{ef}	16.5 ^c	28.8 ^b	49.5 ^c	87.2 ^a	0.018
NDF	64.2 ^c	90.4 ^f	94.7 ^d	9.6 ^b	23.7 ^b	50.0 ^e	96.3 ^a	0.051
ADF	86.9 ^c	93.8 ^e	95.1 ^d	14.5 ^b	23.5 ^a	53.2 ^d	96.5 ^a	0.032

a, b, c, d, e, f Means in same row with different superscripts differ ($P < 0.05$).

Key Words: Byproducts, Degradability, Fermentation

256 Efficacy of a DNA marker for marbling in explaining variation in carcass and performance traits of early-weaned Simmental steers. C. B. Rincker*, N.A. Pyatt, L.L. Berger, and D.B. Faulkner, University of Illinois.

Thyroglobulin 5 (TG5) polymorphism has been associated with an improvement in overall fattening. GeneSTAR[®] Marbling test measures the polymorphism in DNA as either having 0, 1, or 2 copies of the gene; identified as 0-STAR, 1-STAR, or 2-STAR, respectively. Early-weaned steers ($n = 175$, 3/4 Simmental or greater) of known genetics were individually fed over a 4 yr trial period to determine correlations between GeneSTAR[®] Marbling test results and intramuscular fat deposition. The American Simmental Association provided sire and maternal grandsire Expected Progeny Differences (EPDs) for weaning weight (WW), yearling weight (YW), and marbling allowing EPD calculations

to be made for each steer. They were weaned at 88.0 ± 1.1 d and fed a high concentrate diet for 84.5 ± 0.4 d prior to allotment. Steers were subsequently fed a 90% concentrate, whole shelled corn and corn silage diet, supplemented to contain 15.5% CP using SBM for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d. DNA samples were used by Genetic Solutions (Australia) for GeneSTAR[®] Marbling analysis. Marker frequencies 0-STAR ($n=47$), 1-STAR ($n=95$), and 2-STAR ($n=33$) had no significant affect on marbling score, *longissimus dorsi* area, 12th rib fat thickness, quality grade, or yield grade ($P > 0.10$). There was a non-significant ($P > 0.10$) increase in percent Low Choice or higher, 82.6%, 87.4% and 90.9% for the 0-STAR, 1-STAR and 2-STAR steers, respectively. The percent average Choice or higher was respectfully 42.6%, 44.2% and 30.3% ($P > 0.10$) for the three marker populations. No significant differences among performance parameters were due to the frequency of the GeneSTAR[®] marker. In addition, GeneSTAR[®] results were not found to be associated to EPDs for WW and marbling; however, there was a linear increase in YW EPD ($P < 0.05$). These data suggest the potential for a management system by GeneSTAR[®] marker interaction where early-weaning on a high-energy diet may dilute the effects of the marker.

Key Words: Marbling Gene Marker, GeneSTAR[®], Early-Weaned Simmental Steers

257 Effect of level and source of selenium on mass and growth of maternal visceral tissues in growing pregnant ewe lambs. M. A. Ward*¹, J. S. Caton¹, J. B. Taylor², L. P. Reynolds¹, and S. A. Soto-Navarro¹, ¹North Dakota State University, ²USDA-ARS.

To examine the effects of source (organic vs inorganic) and level (0.1 ppm, 3 ppm, and 15 ppm) of dietary Se on maternal visceral tissues, 32 pregnant Targhee ewe lambs (45.6 ± 10.5 kg; 330 ± 30 d) were randomly allotted to one of four treatments in a completely randomized design. Treatments consisted of Control (CON; 0.1ppm), Se-Wheat (SW; 3 ppm), 3 ppm Selenite (S3), and 15 ppm Selenite (S15). The SW diet was formulated using 32% high Se wheat (with a concentration of 8 ppm Se). All diets were similar in N and energy, and fed to meet or exceed nutritional requirements. Diets were initiated at 50 ± 5 d of gestation. Formulation of SW and S3 (supranutritional levels) provided 75 μ g/kg BW of Se, while the S15 (toxic level) provided 375 μ g/kg BW of Se. At day 130 ± 10 of gestation, ewes were slaughtered and tissues harvested. Liver mass (in g/kg; EBW), was greater ($P < 0.10$) in SW and S15 compared with CON (15.0, 17.4, 16.4, and 16.9; ± 0.64 g for CON, SW, S3, and S15 respectively). Blood volume (g) was less ($P < 0.10$) in SW and S3 versus CON; however, S15 did not differ from any other treatments. Liver protein (mg/g) concentrations were greater ($P < 0.05$) in SW and S15 versus CON (95.7, 111.9, 101.1, and 121.6 ± 5.5 g, for CON, SW, S3, and S15 respectively). Jejunal and small intestinal mass (g and g/kg maternal BW), was unaffected by treatment. Jejunal DNA (mg/g), however, was higher ($P < 0.05$) in CON tissue, versus SW and S3. Jejunal mucousal DNA was higher ($P < 0.05$) in SW compared with CON (6.39 vs 5.19 $\pm .33$ mg/g), indicating a greater number of jejunal mucousal cells present in SW treatment. In addition, mucousal protein:DNA and RNA:DNA ratios were lower ($P < 0.05$) in the SW compared with CON (7.75 vs 5.85 ± 0.55 ; 0.86 vs 0.69 ± 0.05 , respectively). These data indicate maternal visceral tissues are responsive to supranutritional levels of selenium in the diet, especially when the source of Se is organic. This appears to be particularly true in the case of jejunal mucousa.

Key Words: Selenium, Pregnancy, Tissue Growth

258 Effect of nutrition on visceral tissue mass and cellularity in late gestation adolescent ewes. J. J. Reed¹, J. S. Caton*¹, D. A. Redmer¹, L. P. Reynolds¹, J. S. Milne², R. P. Aitken², and J. M. Wallace², ¹Department of Animal and Range Sciences, North Dakota State University, ²Rowett Research Institute, Scotland.

Adolescent ewes were used in a randomized design to test the effects of plane of nutrition on maternal organ mass, intestinal growth, and cellular proliferation in late gestation. Singleton pregnancies to a single sire were established by embryo transfer and thereafter ewes were offered a moderate (M, $n=8$) or high (H, $n=11$) level of a complete diet (2.4 Mcal/kg and 14% CP) to promote slow or rapid maternal growth rates. After day 90 of gestation, the feed intake of the M group was adjusted weekly to maintain their body condition score during the final

third of pregnancy while level of food offered to half of the H group was abruptly decreased by 60% to yield a high-low (HL) group. One hour prior to slaughter on d 130 of pregnancy, 5-bromo-2'-deoxyuridine (BrdU; 5 mg/kg BW) was injected into the jugular vein to label dividing cells. Jejunal samples were perfusion fixed with Carnoy's solution, followed by a vascular casting resin, embedded in paraffin, sectioned (5 μ m), and stained (Schiff's reagent with a nuclear staining regimen). Cellular proliferation was determined by image analysis. At slaughter, maternal BW (live BW - gravid uterus) was 40.2, 62.8, and 45.8 \pm 2.1 kg ($P < 0.06$) and body condition score was 2.34, 3.63, and 2.60 ($P < 0.001$) for M, H and HL groups, respectively. Relative liver mass was different ($P \leq 0.004$) for all treatments (18.1, 20.9, and 14.7 g/kg maternal BW for M, H, and HL groups, respectively). Relative jejunum, ileum, and total small intestine masses (g/kg maternal body weight) were similar ($P \geq 0.81$) in H vs HL groups and lower ($P \leq 0.03$) compared with M ewes. Nutritional treatment did not affect ($P \geq 0.10$) jejunal cellular proliferation or jejunal RNA, DNA, and protein concentrations (mg/g); however, total jejunal DNA, RNA, and protein concentration were reduced ($P \leq 0.05$) in HL compared with M and H ewes. Data indicate that intestinal mass as a proportion of maternal BW declines in over nourished gestating adolescent ewes. This response was not alleviated by the HL treatment.

Key Words: Nutrition, Pregnancy, Intestinal Growth

259 Prevalence of *E. coli* O157 in the gut contents and cranial lymph nodes of beef cattle. C. Walker*, T. G. Nagaraja, J. M. Sargeant, M. W. Sanderson, W. Q. Alali, and M. J. Vanbaale, *Kansas State University*.

Cattle are natural reservoirs of *E. coli* O157, a food-borne pathogen, that causes enteritis in humans ranging in severity from mild diarrhea to bloody diarrhea, hemolytic uremic syndrome and death. Fecal shedding of *E. coli* O157 in cattle is because of the ability of the organism to persist in the gut. Recognizing the site of persistence is important to understand mechanisms and factors affecting fecal shedding of *E. coli* O157. The objectives of this study were to determine the prevalence of *E. coli* O157 in the gut (rumen, colon, cecum and rectum) and also in lymph nodes in the head region of cattle. Samples were collected from slaughtered cattle at a packing plant. Eight hundred and fifteen animals, originating from twelve feedlots, were sampled on different days. Contents from rumen, cecum, colon and rectum were obtained and lymph nodes in the head region were sliced and swabbed with a single swab for each animal. Isolation of *E. coli* O157 was by selective enrichment followed by immunomagnetic separation. Identification of *E. coli* O157 was based on indole production, positive agglutination for O157 antigen and API strip results. The overall prevalence of *E. coli* O157:H7 in animals sampled was 20.6%. The prevalence in the rumen, cecum, colon, and rectum was 4.9, 9.1, 7.7, and 10.3%, respectively. Based on matched Chi Square analysis for association, positive relationship existed between rectal and colonic samples ($P < 0.01$) and between rectal and ruminal samples ($P < 0.01$) for prevalence. A total of 697 lymph node samples were cultured and only one animal was positive for *E. coli* O157. It appears that *E. coli* O157 does not colonize the lymph nodes in the head region and fecal shedding is positively associated with persistence in the rumen or colon and not the cecum.

Key Words: *E. coli* O157, Gut Contents, Lymph Nodes

260 Effect of vitamin A on carcass quality and serum status in Angus \times Simmental cattle. N. A. Pyatt*, L. L. Berger, and T. G. Nash, *University of Illinois*.

Vitamin A derivatives play a role in cell growth and differentiation and have been negatively correlated with beef marbling. Three feedlot experiments were conducted to examine the effect of dietary vitamin A level on carcass quality and serum retinol (ROL) status in cattle. All animals were fed similar finishing diets, consisting primarily of whole shelled corn and corn silage. Dietary supplements were calculated to contain either 1650 (LVA) or 6600 IU vitamin A/kg (HVA). Vitamin A content in LVA met NRC requirements while HVA was three times recommended levels. Cattle were harvested at 1.0 cm 12th rib fat thickness. In Exp. 1, 48 early-weaned Angus \times Simmental heifers (309.3 \pm 7.0 kg) were randomly allotted to 12 pens and fed dietary treatments for 163.3 \pm 4.1 d. Serum samples were collected at the initiation, intermediate (d 79) and completion of the experiment. No treatment differences ($P >$

0.05) existed for carcass quality, however intermediate (320.9 vs. 228.0 ng/ml) and final (277.7 vs. 189.5 ng/ml) serum ROL was greater in heifers fed HVA. Vitamin A status and marbling score (MS) were not correlated ($P > 0.05$). In Exp. 2, 42 Angus \times Simmental yearling steers (371.8 \pm 0.8 kg) were randomly allotted to six pens and fed treatment diets *ad libitum* for 105 d. Serum samples were collected at the initiation and completion of the experiment. No treatment differences ($P > 0.05$) existed for carcass quality or serum parameters. In Exp. 3, 144 early-weaned Angus \times Simmental steers (184.8 \pm 1.6 kg) were randomly allotted to 18 pens and fed dietary treatments for 280.1 \pm 3.5 d. Serum samples were collected at the initiation, intermediate (186.7 \pm 1.1 d) and completion of the experiment. Intermediate (281.0 vs. 238.2 ng/ml) and final (322.2 vs. 267.5 ng/ml) serum ROL values were greater ($P < 0.05$) in steers fed HVA. Vitamin A status and carcass quality were not correlated ($P > 0.05$). Dietary intakes of vitamin A at three times NRC recommendations increased circulating levels of serum retinol, but did not affect carcass quality parameters in Angus \times Simmental feedlot cattle.

Key Words: Vitamin A, Carcass Quality, Serum Retinol

261 Effect of limit-feeding on performance and carcass merit of finishing steers. T. B. Schmidt*, K. C. Olson, M. L. Linville, M. M. Brandt, C. A. Stahl, D. L. McNamara, G. K. Rentfrow, C. C. Carr, and E. P. Berg, *University of Missouri*.

Angus steers (n = 84; BW = 379 \pm 24kg) were used to evaluate the effects of limit-feeding on feedlot performance and carcass merit over a 128-d finishing period. Treatments consisted of 2 diets that were formulated to promote a 1.6 kg ADG at intake levels corresponding to approximately 100% (AL) or 80% (80) of *ad libitum* intake. *Ad libitum* intake (% BW) was considered to be the amount of the AL diet that steers would voluntarily consume in 22 h. The AL and 80 diets delivered similar NE and MP at prescribed intake levels. Steers were weighed and diet formulations were adjusted every 28 d during the trial to maintain projected ADG at the targeted intake levels for each treatment. Steers were fed at 0800 daily. Feed bunk scores were recorded at 0600 and 1800 daily (0 to 4 scale; 0 = no feed present, 4 = feed untouched). Bunks of 80 steers scored an average of 1.2, whereas bunks of AL steers scored an average of 2.6 at 1800 each day during the trial. Bunks of steers on both treatments were empty (bunk score = 0) at 0600 each day during the trial. Dietary DMI averaged approximately 2.8% of BW for AL and 2.3% of BW for 80 during the trial. Steers on the 80 treatment had greater ($P < 0.01$) ADG and G:F than AL steers (ADG = 1.76 vs. 1.65 and G:F = 0.15 vs. 0.12 for 80 and AL, respectively). Hot carcass weights for 80 and AL steers were similar ($P = 0.79$; 355 and 356 kg, respectively). Marbling scores (MS) and final yield grades (YG) of 80 and AL steers were likewise similar ($P > 0.05$; MS = modest 20 vs. modest 50 and YG = 3.3 vs. 3.2 for 80 and AL, respectively). Ribeye area, 12th rib fat thickness, and incidence of liver abscesses did not differ ($P > 0.05$) between treatments; however, KPH tended to be greater ($P = 0.06$) for AL compared to 80 steers. Growth performance was greater than that predicted by NRC models when finishing steers were fed a diet formulated to promote 1.6 kg ADG but limited to approximately 80% of *ad libitum* DMI. Level of intake did not exert economically relevant effects on carcass merit.

Key Words: Intake, Feed Efficiency, Restriction

262 Effects of phase feeding of protein on performance, blood urea nitrogen, and carcass characteristics of finishing beef cattle. J. T. Vasconcelos*¹, L. W. Greene¹, N. A. Cole², F. T. McCollum¹, and J. C. Silva¹, ¹Texas A&M University Agricultural Research and Extension Center, ²USDA - ARS.

Forty five crossbred steers (average initial BW = 423 kg) were trained to consume their daily feed from Calan[®] electronic gates feeders. Steers were blocked by weight and used in a randomized block design to determine the performance, blood urea nitrogen (BUN), and USDA carcass characteristics when fed different dietary CP strategies. A finishing diet containing 10% roughage (DM basis) was formulated to contain 13% CP (DM basis) and was fed *ad libitum* for 62 d. Supplemental CP was provided from an equal amount of N provided by urea and cottonseed meal (CSM). On d 62, the dietary CP was maintained at 13% or reduced to 11.5% (by removing equal amounts of N from urea and CSM) or to approximately 10% CP. At the time of the diet change, the average BW of

steers was 536 kg. Steers were harvested when they had approximately 25 mm of external fat. On the day of harvest (d 109) the average BW was 585 kg. Reducing the CP content of the diet did not affect ($P = 0.51$) ADG of steers (1.12, 1.06 and 0.99 kg/d for no supplemental protein, 11.5% CP and 13% CP, respectively) from d 62 to 109. The ADG of steers was similar ($P = 0.85$) over the 109 d feeding period regardless of dietary CP treatment (1.49, 1.50 and 1.45 kg/d for approximately 10% CP, 11.5% CP, and 13% CP, respectively). No differences among treatments were detected for BUN concentrations on d 0, 62, and 109 ($P = 0.65$, $P = 0.49$, and $P = 0.12$, respectively). Dry matter intake ($P = 0.81$), gain:feed ratio ($P = 0.98$), external fat thickness ($P = 0.30$), longissimus area ($P = 0.19$), and percentage of internal fat ($P = 0.27$) were not different. These data suggest that dietary CP levels can be reduced to conserve N during the final stages of finishing without any reduction in ADG. Reducing supplemental CP from natural CP sources will also reduce dietary P intake and subsequent excretion.

Key Words: Feedlot, Nitrogen, Phosphorus

263 Evaluation of different pasture sampling methods to simulate forage selected by grazing cattle. J. R. Russell, M. A. Parlett*, K. Bormann, and W. J. Powers, Iowa State University.

An experiment was conducted to evaluate the accuracy of different hand-sampling methods to predict the composition of forage selected by grazing cattle. Each of six 2.02-ha smooth bromegrass pastures were rotationally stocked with 4 Simmental cross cows with calves from May to September with or without first-cutting hay harvest to control excess forage growth. In May, July and September, forage selected during grazing was collected by ruminal evacuation from one steer fitted with a ruminal cannula per pasture and freeze-dried. Simultaneously, forage was sampled by hand-clipping at heights of ground level, 5 cm, and 10 cm or by hand-plucking. Live forage from samples hand-clipped at ground level was sorted by hand and used for analysis. Forage samples collected by hand were dried at 65degC for 48 h. All samples were ground through a 1-mm screen and analyzed for IVDMD, CP, NDF, and ADF. Mean concentrations of IVDMD, CP, NDF, and ADF were 63.4, 16.0, 49.2, 28.4; 49.5, 12.5, 56.4, 35.9; and 51.2, 13.3, 57.4, 35.6 % of DM in forage sampled in May, July, and September (Month, $P < 0.01$). Mean concentrations of NDF were higher ($P < 0.01$) and mean concentrations of CP and IVDMD were lower ($P < 0.01$) in forage collected by hand using all methods than in forage collected by ruminal evacuation. These errors were greatest in July (Method x Month, $P < 0.01$). Mean ADF concentrations of forage collected by hand-clipping at ground level and hand-sorting did not differ from forage collected by ruminal evacuation. Regression equations predicting the IVDMD concentrations of forage samples collected by ruminal evacuation with samples hand-clipped at 5 ($y = 41.1 + 0.37x$; $r^2 = 0.40$) and 10 ($y = 44.7 + 0.30x$; $r^2 = 0.37$) cm were significant. The regression equation predicting the CP concentrations of forage samples collected by ruminal evacuation with hand-plucked samples ($y = 12.0 + 0.43x$; $r^2 = 0.30$) were also significant. Without consideration of sward characteristics, no method of hand-sampling accurately reflected the composition of forage selected by grazing cattle.

Key Words: Cattle, Grazing, Forage

264 Quality and quantity evaluations of shade-grown legume forages. K. P. Ladyman*¹, M. S. Kerley¹, R. L. Kallenbach¹, H. G. Garrett¹, R. L. McGraw¹, and J. W. Van Sambeek², ¹University of Missouri, ²USDA Forest Service.

Seven legumes were grown during the summer-fall of 2000, at the Horticulture and Agroforestry Research Center (39 01' N, 92 46' W) near New Franklin, MO. The forages were grown in 7.5-L white pots placed on light-colored gravel either under full sunlight, 45% sunlight, or 20% sunlight created by suspending shade cloth over a rectangular frame. Forages were grown in a well-drained potting medium with a complete slow-release fertilizer and irrigated daily. Forages were sown and germinated in the greenhouse between May 18 and June 14 and put outside into the shade study between June 21 and June 30. Forages were harvested in August and again in October. Forages were analyzed for N (nitrogen), NDF (neutral detergent fiber), ADF (acid detergent fiber), and NDFIS (neutral detergent fiber in situ digestibility). Three of the legume species had greater ($P > 0.05$) forage production at 45% sunlight than in full sunlight. As the sunlight intensity decreased, most forage

species yielded greater ($P > 0.05$) concentrations of both nitrogen and fiber. Fiber digestibility was higher ($P > 0.05$) or unchanged ($P > 0.05$) for most forage species as sunlight intensity was decreased. All seven legumes are acceptable species for use in a silvopastoral practice to improve forage productivity and quality as compared to an open pasture environment.

Key Words: Fiber Digestibility, Light Intensity, Forage Quality

265 Evaluation of a nutritional supplement used for pre-weaning liquid feeding programs on calf performance and health. H. Chester-Jones*¹, R. Larsen², C. Soderholm², B. Ziegler², S. Hayes³, D. Ziegler¹, J. Linn⁴, and A. DiCostanzo⁴, ¹University of Minnesota Southern Research and Outreach Center, ²Hubbard Feeds, ³Milk Products, ⁴University of Minnesota Department of Animal Science.

Forty-eight purchased Holstein bull calves (BW = .3 kg) were used in a 56-d study to determine the effects of using a nutritional supplement to replace antibiotics in medicated milk replacers (MR), on pre-weaning and immediate post weaning performance and health. Calves were blocked by initial BW and total serum proteins taken upon arrival. Calves were placed within inside raised-stalls and 16 calves were assigned to each of three MR treatments:- a) Non-medicated 20:20 MR (NMMR); b), NMMR mixed with a nutritional supplement at 20 g/calf twice daily from 1 to 14 d and 10 g/calf twice daily from 15 to 42 d (CCMR; *Calf Compass*[®]) and c), Neo-Terramycin medicated 20:20 MR (MMR). Calves were fed 0.28 kg of MR powder reconstituted to 12.5% DM with water twice daily for 42 d and once a day from 42 d to weaning at 49 d. Calves were full fed an 18% CP calf starter and offered fresh water daily. Average daily gains from 1 to 42 d were lower ($P < 0.01$) for calves fed NMMR compared to those fed MMR with CCMR fed calves being intermediate to the other groups ($P < 0.2$). Total DMI from MR d 1 to 42 averaged 23.1 kg and for the calf starter phase: 17, 20.9 and 20.5 kg for calves fed NMMR, CCMR and MMR, respectively. Total DMI and gain from 1 to 56 d were 62.5, 29.8; 67.6, 34.0; 68.9 and 35.5 kg for calves fed NMMR, CCMR, and MMR, respectively. Fecal scores were higher for all calves during the first 14 d (average 2.7; 1= normal; 4 = watery) but decreased similarly across calf groups to an average of 1.07 from d 42 to 56. Health costs from 1 to 56 d related to scours and respiratory infections were 11.60,8.93; 8.90,7.37; 11.36and7.41 for the NMMR, CCMR, and MMR calf groups, respectively. Results from this study indicated that calves fed MR with a nutritional supplement performed as well as those fed an antibiotic medicated MR.

Key Words: Dairy Calves, Growth, Medication

266 Growth response of wheat pasture stocker cattle to alternate day feeding of a monensin-containing energy supplement. B. G. Fieser* and G. W. Horn, Oklahoma Agricultural Experiment Station.

This experiment was conducted during the winter of 2002-03 to evaluate the feeding of a monensin-containing energy supplement on alternate days on growth of steers grazing winter wheat pasture. Seventy-eight Angus-crossbred steers (initial BW = 240 ± 24 kg) were grazed 120 days (Nov. 13 to Mar. 13) on six different pastures in a randomized complete block design. Pastures were blocked by location, while steers were stratified by initial weight and randomly allocated to treatments. Average stocking rate was 1.46 steers/hectare. Dietary treatments were either a mineral mixture (offered free-choice) or a monensin-containing energy supplement. The energy supplement was formulated to contain 352 mg of monensin per kg of supplement (as-fed). Supplement was offered every other day at a rate of 0.91 kg/steer, to achieve a target daily monensin intake of 160 mg/steer. Daily supplement intake across all supplemented pastures averaged 0.41 ± 0.09 kg/steer, resulting in a daily monensin intake of 143 mg. Daily supplement intakes for individual pastures ranged from 0.39 ± 0.10 to 0.43 ± 0.06 kg/steer. Despite these minimal differences, the consumption pattern of supplements was highly variable between and within pastures. Daily mineral consumption averaged 0.13 kg/steer. Daily gains and overall gains were increased ($P < 0.03$) by feeding the monensin-containing supplement. Daily gains of supplemented steers were 0.11 kg greater than those of steers receiving mineral alone, 1.45 vs. 1.34 kg. Overall gains were increased 15 kg by supplementation (167 vs. 152 kg). Supplement conversion, expressed as

kg of supplement consumed per kg of additional gain compared to control steers, averaged 4.40. Despite supplement intakes slightly less than targeted, these data indicate that a daily dose of monensin capable of eliciting a positive gain response can be provided to cattle in an energy supplement fed every other day at the rate of 0.91 kg/steer.

Key Words: Wheat Pasture, Monensin, Supplementation

267 Digestible energy content of diets differing in concentration of soybean hulls and corn fed to growing lambs. J. Rekhis*² and T. Johnson¹, ¹Purdue University, ²Manouba University.

The objective of this study was to determine apparent digestibility of gross energy, organic matter, fiber and efficiency of nutrient utilization of diets containing increasing levels of soy hulls in replacement of corn in diets fed to growing lambs. Basal diet contained ground corn, soybean hulls, and hay crop silage. Soy hulls replaced corn at 25, 50, 75, or 100%. All lambs were fed ad libitum concentrate (1450 to 1800 g DM /day) and hay crop silage at 10% diet DM. Diet D, with 25% soy hulls, is the basal diet. Twelve whether lambs (27 to 34 kg BW) were assigned in a 3-period switch-back. Each period contained 21 d, 14-d adaptation and 7-d total collection of urine and feces. Composition of diets A, B, C, D, and soy hulls were respectively, 84.1, 83.8, 84.9, 82.7, and 90.5% of DM; 90.5, 93.02, 93.9, 94.2, and 95.1% of OM; 3.95, 3.82, 3.85, 3.84 and 3.78 Kcal GE/g; 3.23, 3.16, 3.01, 2.68, and 2.57% NDF; and 39.9, 36.5, 27.6, 17.1 and 44.1% ADF. Intake and apparent digestibility of DM, and OM were not different between treatments. Intake of ADF, g/d, was significantly increased as soy hulls replaced corn (P < 0.01), however diet digestibility of ADF was also significantly increased as soy hulls replaced 100% of dietary corn (P < 0.05). Apparent digestibility of OM, and ADF were not compromised by replacement of corn with soy hulls in diets fed growing lambs. Gross energy and digestible energy consumed by lambs fed all diets were not different

DIET	A	B	C	D	SE	SIGNIFI- CANCE
DM-intake g/d	1489.0	1514.3	1388.2	1436.5	63.5	ns
DM Dig. %	67.4	72.2	70.6	76.5	2.8	A vs. D, P<.10
OM intake, g/d	1391.0	1414.0	1326.5	1371.8	62.7	ns
OMD, %	69.2	73.7	75.3	74.9	3.0	ns
ADF-intake, g/d	625.3	580.7	441.3	283.3	9.3	P<.01
ADF-Dig. %	60.5	64.8	56.8	53.8	3.0	B vs. D, P<.05; B vs. C P=.10
GE Intake, Mcal/d	6.21	6.20	5.59	5.86	0.3	ns
Fecal energy, Mcal/d	1.89	1.73	1.70	1.52	0.12	A vs D, P=.10
DE, Intake, Mcal/d	4.31	4.47	3.90	4.33	0.28	A vs. D, P=.10

Key Words: Lambs, Soy Hulls, Digestible Energy

268 Field peas in preconditioning diets for beef calves. V. L. Anderson* and C. L. Stoltenow, North Dakota State University.

The acreage of field peas, a palatable and nutrient dense annual legume, is increasing in the Northern Plains states and provinces. The energy level of field peas is similar to corn and the crude protein ranges from 23-25 percent. Peas may best be utilized where feed intake is limited or palatability is an issue. A two-year preconditioning study was conducted at the Carrington Research Extension Center with newly weaned, producer-owned, spring-born, beef calves (n=144 in 2001 and n=150 in 2002, avg wt 260.4 kg). The calves originated from 34 different ranches in 2001 and 39 different ranches in 2002. The three 60% concentrate diets were formulated (NRC, 1996) with 1) 100% barley (BAR), 2) 50% barley, 50% peas (BAR-PEA), or 100% peas (PEA). A metaphylactic injection of Micotil was given on arrival. Calves had previously been vaccinated and boosted for IBR, BVD, PI3 and 7 Way with somnus. Calves were weighed on arrival, on d 21 (Period 1) and d 42 (Period 2), when the trial terminated. The totally mixed diets included dry rolled grains, corn silage, chopped alfalfa hay, and Rumensin fed at 250 mg/hd/d. During the first 28 days, YeaSacc 1026 and Deccox were also

included. Dry matter intake (DMI), gain, feed efficiency, morbidity, and mortality were monitored. Data were analyzed using SAS GLM procedures. No differences were detected in DMI (P>.05) due to treatment during Period 1 but during Period 2 and overall, a positive linear response (P<.05) was observed due to level of peas in the ration. DMI overall was 6.60, 7.02, and 7.50 kg for BAR, BAR-PEA, and PEA treatments, respectively. Daily gains were similar (P>.05) for the BAR (1.51 kg) and BAR-PEA (1.50 kg) treatments but greater (P<.05) for the PEA treatment (1.60 kg). Gains per unit feed were not different (P>.05). Similar numbers of calves were pulled from each treatment. No calves died during the study. While improved daily gains were observed only for the high level of peas in this study, increasing dry matter intake is critical to optimum health and performance. Adding field peas to the diet enhanced feed intake.

Key Words: Field Peas, Preconditioning, Beef Calves

269 Effects of grain processing for backgrounding diets on performance of beef steers. G. P. Lardy, W. L. Bengochea*, M. L. Bauer, T. C. Gilbery, and S. A. Soto-Navarro, North Dakota State University.

One hundred forty-one crossbred steers (319.7 ± 5.5 kg initial BW) were used to evaluate the degree of processing (coarse and fine particle size) on two types of grain (corn and barley) in backgrounding diets. Treatments were arranged in a 2 x 2 factorial in a randomized complete block design. Steers were sorted by weight into three blocks, stratified by weight, and allotted randomly to one of four treatments (6 pens/treatment). The diet contained (DM basis) 40% dry-rolled grain (barley or corn), 34% corn silage, 15% ryegrass hay, 6% supplement, and 5% desugared molasses. Diets were formulated to contain a minimum of 12.5% CP, 0.6% Ca, 0.3% P, 0.6% K, and 27.5 mg/kg monensin. Steers were implanted with Synovex-S prior to the start of the trial, and were weighed every 28 d with a 3 d average weight taken at the beginning and end of the trial. Steers were fed for 84 d. Final weight and average daily gain were not affected by either degree of processing or type of grain (P ≥ 0.13). Steers fed corn had greater DMI (P = 0.05) than steers fed barley. There was a grain type x processing degree interaction (P = 0.09) for gain to feed ratio. Steers fed finely rolled barley had an improved gain to feed compared with the fine rolled corn treatment; whereas coarsely rolled corn and barley were not different. In conclusion, performance of backgrounding steers was improved by finely processing barley but finer processing does not appear to improve performance with corn. This study suggests there are no benefits to finely processing corn for backgrounding diets; however, feed efficiency can be improved by finely processing barley for feedlot steers.

Effect of grain processing for backgrounding diets on performance of beef steers

Item	Barley		Corn		SEM	Effect		
	Coarse	Fine	Coarse	Fine		Grain	Proc	Grain X Proc
Final weight, kg	439.2	445.0	438.7	441.7	3.4	0.57	0.21	0.68
Daily gain, kg	1.38	1.50	1.46	1.43	0.08	0.91	0.92	0.13
DMI, kg/d	9.57	9.29	9.81	10.00	0.23	0.05	0.38	0.22
Gain:Feed g/kg	137	155	147	133	9	0.53	0.83	0.09

Key Words: Barley, Corn, Particle Size Processing

270 Effect of commingling ranch cattle with cattle from multiple sources on receiving health and performance, feedlot performance and carcass quality. H. A. DePra*, D. L. Step, D. R. Gill, and C. R. Krehbiel, Oklahoma State University.

The objective of our experiment was to determine health and performance of ranch calves when commingled with calves from multiple sources. A total of 309 steers were received during December 2002. Steers, within origin, were blocked by initial BW. Steers from a single ranch were vaccinated with MLV and weaned for 45 d (RVAC, initial wt = 274 ± 21 kg). Steers from the same ranch were weaned for 45 d, but did not receive any vaccinations (RNO, initial wt = 231 ± 26 kg). Multiple source steers were purchased through auction markets (SALE, initial wt = 238 ± 13 kg), and upon receiving, a portion of ranch steers (RVAC and RNO) were commingled with a portion of SALE cattle (CVAC and

CNO, initial wt = 251 ± 15 and 234 ± 19 kg, respectively). Multiple-source and RNO steers were vaccinated on arrival. Four pens/trt were utilized with 13 to 16 steers/pen. Average daily gains were 1.24, 1.25, 1.11, 1.23, and 1.17 kg/d, respectively, for RVAC, RNO, SALE, CVAC, and CNO, and were greater ($P < 0.01$) for ranch vs SALE (2.74 vs 2.44 kg/d, respectively). During receiving, DMI did not differ (2.5% BW; $P = 0.51$) among treatments, nor did mortality (avg 1.6%; $P = 0.29$). Morbidity was 2.00, 1.75, 26.75, 15.75, and 9.5%, respectively, for RVAC, RNO, SALE, CVAC, and CNO. Steers were shipped to a commercial feedyard following receiving. Ranch calves consumed an avg of 8.65 kg DMsteer⁻¹d⁻¹ and gained an avg of 212 kg/steer, while multiple-source calves consumed 8.05 kg DMsteer⁻¹d⁻¹ and gained an avg of 216 kg/steer. Ranch and multiple-source calves were harvested after 152 and 158 d on feed, respectively. Cattle commingled during receiving had a lower ($P < 0.01$) yield grade (YG) than cattle of ranch origin (2.3 vs 2.5), and multiple-source steers had lower ($P < 0.001$) YG than ranch origin steers (2.0 vs 2.5). Quality grade did not differ for any treatments or contrasts. As expected, morbidity was higher for multiple-source cattle. In our experiment, health and performance were not different for RVAC and RNO steers.

Key Words: Commingling, Shipping Fever, Stress

271 Effects of high fiber receiving rations containing wheat midds and soybean hulls with and without yucca schidigera extract on the performance of beef steers. K. E. Earing*, P. M. Walker, and L. A. Mathews, ¹Illinois State University.

One hundred seventy-six Angus crossbred steers (mean wt. = 284 kg) were assigned to a randomized complete block design (BW) in a 2 x 2 factorial arrangement (24 pens containing 6 or 10 steers per pen) to evaluate the influence of Yucca Schidigera Extract- sarsaponin (YS) and high fiber receiving rations (45.7 ± 4.5% ADF) with and without wheat midds and soybean hulls (WS) (40.0% and 23.0% of the ration DM, respectively) on pre-finishing and finishing performance. During Phase 1 (P1) all cattle were fed grass hay ad libitum and a receiving ration at 2% of BW (wet wt. basis) containing 12.5% CP and 22% CF with or without YS (1100 ppm) for 18d. During Phase 2 (P2) cattle were fed grass hay ad libitum and a ration at .95% of BW containing either wheat midds and soybean hulls, or shelled corn and protein concentrate (SP) in a 75:25 ratio for 31d. All cattle were fed the same corn silage- shelled corn based diet during Phase 3 (P3). Similar performance ($P > 0.05$) was observed during P1 for steers whether or not the diet contained YS. During P2 steers consuming WS had higher ($P < 0.04$) ending wt., higher ($P < 0.05$) DMI, and no difference ($P > 0.1$) in ADG or G:F ratio. No significant interactions were observed between P1 and P2 diets on P2 and P3 steer performance or carcass characteristics at harvest. Receiving diets supplemented with wheat midds and soybean hulls resulted in similar to greater steer performance compared to diets containing SP. Supplementing grass hay receiving rations with wheat midds and soybean hulls compared to shelled corn and a traditional protein concentrate can result in similar to greater steer performance during the receiving period with no effect on finishing performance. Supplementing receiving diets with Yucca Schidigera Extract did not improve steer performance.

Key Words: Steers, Receiving Rations, Wheat Midds and Soybean Hulls

272 Effect of age gender and barley grain processing method on performance and diet digestibility of beef cattle. B. M. Rainey*, J. A. Paterson, T. T. Standley, L. M. Duffey, and W. T. Choat, Montana State University.

A performance and two digestibility studies were conducted to test the effects of animal age, animal gender and barley processing method when barley was fed as a supplement to grass hay at 0.5% of BW. All animals received a 37% CP supplement. The first digestibility study was conducted using sixteen Angus crossbred cows and 16 steer calves. Data were analyzed as a 2 x 2 factorial. No age x processing interactions were detected for OM, N, ADF or NDF digestibilities. Organic matter and N digestibilities were greater ($P < 0.01$) for calves compared to cows, but ADF and NDF digestibilities were similar. Processing the barley did not influence OM, N, ADF, or NDF digestibilities. A processing method x age interaction was observed ($P < 0.05$) for starch digestibility. Processing did not affect starch digestibility when fed to calves, but rolling the barley dramatically improved starch digestibility (71.4% vs. 23.3% for rolled vs. whole) for cows. The performance study consisted of forty

Angus cows, twenty-one heifer calves, and nineteen steer calves allotted to treatments in a 2 x 2 x 2 + 1 arrangement. All cattle were blocked by age and sex. No interactions were measured in this study. Animals fed the unsupplemented diet had similar ($P > 0.05$) rates and efficiencies of gain as barley supplemented animals. Barley processing had no effect ($P > 0.05$) on rate or efficiency of gain for cows or calves. However, cows gained ($P < 0.05$) weight faster than calves, consumed more ($P < 0.05$) DM but were less efficient (12.6) than calves (avg. 7.6). The second digestibility study was conducted using animals from the performance study. Unlike the first digestion study no differences were observed for digestibility of OM, N, ADF, NDF, or starch between cows vs. calves or whole vs. rolled barley supplements. These data are inconclusive and suggest that further research is needed in testing effects of age and barley processing methods on diet digestibilities and performance.

Key Words: Barley, Processing, Cattle

273 The effect of removing roughage from the diet on digestibility and fermentation characteristics *in vivo*. C. A. Willis* and M. S. Kerley, University of Missouri.

Three ruminally and duodenally cannulated crossbred steers were used in a 3x3 Latin square site and extent of digestion study designed to test the effects of removing roughage from the diet on digestion and fermentation characteristics in the rumen. Diets fed were whole corn-based (13.3% CP) and contained 15.2% hay (H), 16.7% soyhulls (SH), or 0% roughage (NR). Hay and SH percentages were balanced to provide similar NDF content between diets. Steers were weighed at the beginning of each period and fed at 1.8% of BW per day. Chromium oxide and cobalt-EDTA markers were used to determine digestibility and liquid dilution rates. Ruminal and duodenal samples were taken every 6-h with sampling times advanced 2-h each day so that every 2-h were represented over a 24-h period. Diet had no effect ($P > 0.05$) on total VFA concentrations, total tract digestibility, liquid dilution rate, and microbial N flow to the duodenum. Ruminal digestibility for the NR diet was greater ($P < 0.05$) than for H or SH diets with averages of 56.9, 48.7, and 48.1% for NR, H and SH, respectively. Microbial efficiency (MOEFF) was different ($P < 0.05$) among diets. Ruminal ammonia concentrations were lowest ($P < 0.05$) for the SH diet. Fecal output was different ($P < 0.05$) among diets (5.3, 2.0, and 3.8 kg excreted for H, NR, and SH, respectively), being the lowest ($P < 0.05$) for the NR diet. Removing roughage from the diet shifted a greater proportion of digestion to the rumen. MOEFF was reduced when roughage was removed from the diet; however microbial N flow to the duodenum was not influenced by presence or form of roughage. Removing roughage from the diet reduced fecal waste excretion by approximately two-thirds in this experiment.

Key Words: No Roughage, Microbial Efficiency

274 Effects of *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* on growth performance and carcass characteristics of finishing beef cattle. M. A. Greenquist*¹, J. S. Drouillard¹, G. E. Erickson², T. J. Klopfenstein², and B. Dicke³, ¹Kansas State University, ²University of Nebraska, ³Cattleman's Consulting.

Yearling crossbred beef steers and heifers (n=3,539; 362 kg BW) were used in an experiment conducted at a commercial feedlot operation to characterize growth performance and carcass characteristics associated with the supplementation of direct-fed microbials (DFM) from *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* in finishing cattle diets. Every other animal within each replicate was assigned to either a control or treatment pen. Direct-fed microbials were incorporated into a steam-flaked corn finishing diet using a microingredient application system. The experimental diets provided 1 10⁹ cfu *P. freudenreichii* strain NP 24, 1 10⁶ cfu *L. acidophilus* strain NP 45, and 1 10⁹ cfu *L. acidophilus* strain NP 51 per animal daily. Cattle were acclimated to their final finishing ration over a period of two to three weeks and fed for an average of 122 d. Direct-fed microbial supplementation had no significant effects on DMI (9.70 vs 9.69 kg; $P = 0.92$), ADG (1.54 vs 1.51 kg; $P = 0.41$), or feed efficiency (0.158 vs 0.156; $P = 0.27$) for control vs DMF cattle. Final adjusted weights and carcass characteristics were similar ($P > 0.10$) between the two treatments. The results of this experiment indicate that growth performance and carcass characteristics of yearling crossbred beef steers and heifers fed in a commercial feedlot environment were not influenced by daily supplementation with 1 10⁹

cfu *P. freudenreichii* strain NP 24, 1 10^6 cfu *L. acidophilus* strain NP 45, and 1 10^9 cfu *L. acidophilus* strain NP 51.

Key Words: Direct-fed Microbials, Finishing Cattle, Performance

275 Supplemental dried distillers grains reduces intake of grazed forages. J. C. MacDonald*, T. J. Klopfenstein, G. E. Erickson, and C. N. Macken, *University of Nebraska*.

The cost of grazed forages in Nebraska has increased an average of 2.3% per year over the past ten years while the price of corn has remained relatively constant within a cyclical price pattern. As the supply of dried distiller grains (DDG) continues to increase, they will likely be priced relative to corn. DDG may fit well as a grazed forage supplement because they provide undegradable intake protein (UIP) and highly fermentable fiber that may not negatively affect forage digestibility. Data were collected to quantify effects of DDG supplementation on ADG and forage intake (FI), and to determine the value of DDG in grazing enterprises. Thirty heifers (295 kg, SD=36 kg) grazing smooth bromegrass (IVOMD = 65.1%, CP = 16.9%, UIP = 1.0%) were each supplemented daily with 0, 0.48, 0.95, 1.43, or 1.90 kg (DM) DDG (CP = 29.5%, UIP = 17.7% ether extract = 8.5%) for 84 d from April 20 to July 13, 2002. FI was estimated using the 1996 NRC model. TDN inputs were 100% and 61.5% for DDG and smooth bromegrass, respectively. Non-supplemented controls gained 0.70 (± 0.12) kg per d and consumed 7.75 (± 0.54) kg forage per d. Increased DDG supplementation resulted in a linear decrease in FI ($P < 0.01$) and a trend for a linear increase in ADG ($P = 0.12$). Effect of DDG supplementation on FI was described by the equation $FI = 7.91 - 1.66x$ ($r^2 = 0.57$) where x = kg of daily DDG supplement. This suggests a strong substitution effect. This relationship can be used to determine DDG value as a result of reduced forage costs. DDG may be an attractive forage supplement due to cost savings from decreased forage intake. Increased ADG would further improve the economic benefit of DDG supplementation.

Key Words: ADG, Dried Distillers Grains, Forage Intake

276 Distillers dried grains with solubles affects fatty acid profile in beef. P. A. Lancaster*, J. E. Williams, J. B. Corners, and L. N. Thompson, *University of Missouri*.

Sixteen steers (399.8 ± 30.2 kg) were allotted by weight to one of two treatments to test the effects of distillers dried grains with solubles (DDGS) as a fat source to change the fatty acid profile of muscle tissue. Treatments consisted of: 1) soybean meal (SBM, 7% of DM); 2) DDGS, 15% of DM; both added to a whole shelled corn, soybean hulls, and fescue hay based diet. Steers were kept in two (one pen per treatment) 18.3 m x 70.1 m drylots with 19.4 m² of shelter and 4.6m of bunk space, which were the exact mirror image of one another. Steers were adapted to the finishing ration at which point treatments began and continued for 77 days. Treatments were maintained at similar levels of DMI. Initial, final, and hot carcass weights were not different ($P > 0.10$) between treatments. Fat depth, marbling score, and ribeye area also did not differ ($P > 0.10$) between treatments. Animals were slaughtered at the University of Missouri abattoir at which time a 2.54cm cross section of the longissimus dorsi muscle was taken between the 11th and 12th rib, all non-intramuscular fat removed, and frozen at 80 °C for fatty acid analysis. Extracted fat tissue was separated into triglyceride and phospholipid fractions. Fatty acids are reported on a weight percentage basis. There was a trend for DDGS to increase ($P = 0.14$) the amount of saturated fatty acids and increase ($P = 0.13$) the amount of monounsaturated fatty acids over SBM in the triglyceride fraction (47.57 vs. 57.31% and 49.90 vs. 40.44%, respectively). There was also a trend in the triglyceride fraction for DDGS to increase ($P = 0.12$) the total amount of 18 carbon unsaturated fatty acids (55.38 vs. 38.61%, respectively). In the phospholipid fraction, DDGS decreased ($P < 0.01$) the amount of palmitoleic acid (0.68 vs. 1.02%, respectively) and increased ($P < 0.05$) the amount of linoleic acid compared to SBM (29.29 vs. 20.73%, respectively). DDGS also increased ($P < 0.05$) the amount of polyunsaturated fatty acids (43.65 vs. 32.45%, respectively). In conclusion, DDGS increased the amount of unsaturated fatty acids having a greater effect in the phospholipid than the triglyceride fraction.

Key Words: DDGS, Fatty Acids, Longissimus Dorsi

277 Influence of limit-fed dry corn gluten feed and distillers dried grains with solubles on performance, lactation and reproduction of beef cows. D. W. Shike*, D. B. Faulkner, and J. M. Dahlquist, *University of Illinois*.

One hundred Simmental cows nursing calves were utilized to determine the effects of distillers dried grains with solubles (DDGS) and corn gluten feed (CGF) on performance, lactation and reproduction. Diets contained ground alfalfa hay and either DDGS or CGF. The isocaloric diets were limit-fed to meet cow maintenance and lactation requirements. Cows were maintained in a dry lot and fed in fence-line bunks. Cows were blocked by age and calving date and randomly assigned to treatments after calving. Treatments ended at the initiation of the breeding season. Final cow and calf weights were taken at this time. Corn Gluten Feed supplementation decreased ($P < 0.05$) cow ADG by 0.21 kg/d compared to DDGS supplementation. Corn Gluten Feed supplementation increased ($P < 0.05$) milk production (10.18 kg/d) compared to DDGS supplementation (9.33 kg/d). Calf ADG tended ($P < 0.10$) to be higher for CGF supplementation (1.05 kg/d) compared to DDGS supplementation (0.97 kg/d). Treatment did not influence ($P > 0.05$) milk urea nitrogen or percent fat in milk. However, there was a trend for higher ($P < 0.10$) percent protein in the milk in CGF supplemented cows. Cows supplemented with CGF also had higher ($P < 0.05$) total protein in the milk, but they had lower ($P < 0.05$) total fat in the milk compared to DDGS supplemented cows. There was no difference ($P > 0.05$) in artificial insemination conception rate. There was also no difference ($P > 0.05$) in overall pregnancy rate following a 45 d period with clean-up bulls. Feeding lactating cows CGF decreased cow performance but resulted in higher milk production and a trend for higher calf performance compared to DDGS supplementation. There was no difference detected in reproduction between cows supplemented with CGF or DDGS.

Key Words: Corn Gluten Feed, Distillers Grains, Cows

278 Performance and carcass value of Holstein steers fed corn distillers grains. A. Trenkle*, *Iowa State University*.

One hundred ninety-two 195 kg Holstein steers were allotted randomly to 32 pens. Steers were fed diets of dry rolled corn, corn silage, chopped hay and supplement. Dietary treatments were the basal diet supplemented with urea or soybean meal (SBM) & urea and replacing corn and protein supplement with 10, 20 or 40% of diet dry matter as wet (30% DM) or dry (90% DM) distillers grains with solubles (DGS). Data were summarized at d 91 to represent a growing program. At 91 d the average live weight across diets was 320 kg. Steers fed SBM consumed more feed, gained faster and were more efficient than those fed urea (6.2 kg DM/d, 1.48 kg/d & 4.21 compared with 6.0, 1.37 & 4.40, $P < .05$). Those fed 40% wet DGS consumed less feed and gained less ($P < .05$) but were more efficient ($P < .05$; 4.5, 1.14 & 4.01) than those fed urea or SBM. Steers fed dry DGS or 10 and 20% wet DGS had performance similar to those fed urea. For the total finishing period (299 d) there were no significant differences in performance (feed intake, ADG & F/G) of steers fed SBM or urea (8.8, 1.43, & 6.17 and 8.8, 1.43 & 6.18). There were no differences in carcass weight, dressing %, yield grade, ribeye area, backfat thickness, or quality grade of steers fed SBM or urea. Those fed SBM had more marbling ($P < .05$, 637 vs 565). Feeding wet or dry DGS did not affect performance except those fed 40% wet DGS consumed less feed and gained less with the same feed efficiency ($P < .05$, 7.8, 1.26 & 6.19) as those fed urea or SBM. Carcass measurements of steers fed wet or dry DGS were not different from those fed urea, except steers fed 40% wet DGS had lighter carcasses ($P < .05$). Diets had no effects on carcass quality grades. Averaged across diets carcass grades were 46.0% Choice or greater, 37.0% Choice-, and 17.0% Select; 14.8% YG 1, 59.7% YG 2, 25.0% YG 3 and 0.5% YG 4. Carcass value based on actual market value when sold or based on a grid giving value to carcasses with higher quality grades and YG 1 or 2 and discounting Select and YG 4 carcasses was not affected by diet. These data indicate that wet or dry DGS can be fed to Holstein steers in a contract program based on quality grade.

Key Words: Distillers Grains, Holstein Steers

279 Phase feeding and comparison of Jersey and Holstein steers. J. W. Lehmkuhler*, D. M. Schaefer, S. C. Arp, and A. M. Brokman, *University of Wisconsin*.

A study involving twelve Jersey and twelve Holstein steers of similar ages compared breed responses when offered diets formulated to maintain metabolizable energy to amino acid allowable gain ratios near 1.0. The CNCPS model was utilized to develop a three phase feeding program involving moderate levels of forage (FOR) or greater amounts of concentrate (CON) for the first two periods with the last phase (76 d) being a common finishing ration offered to all steers. For Phases 1 and 2 (91 d and 83 d, respectively), diets were formulated to allow gains of 0.90 kg/d and 1.36 kg/d. Steers were implanted and reimplanted with an estrogenic product. Steers were blocked by breed, individually penned and randomly assigned to dietary treatments. By design Holstein steers were heavier ($P < 0.05$) than Jerseys at the initiation of the trial (228 kg vs. 116 kg). A dietary treatment response ($P = 0.05$) was observed only for gain efficiency during Phase 1 in which CON was greater than FOR (0.22 vs. 0.20). Breed differences in daily gains were present ($P < 0.05$) for all phases with Holstein steers gaining faster than Jersey steers. DM intakes were greater ($P < 0.05$) for Holsteins, however, gain efficiency was greater ($P < 0.05$) for Jerseys during Phases 1 and 3. Carcass traits were not influenced ($P > 0.05$) by dietary treatment. Holsteins had heavier hot carcass weights, greater dressing percentages and larger ribeye areas ($P < 0.05$) while marbling scores and backfat depths were similar ($P > 0.05$) to Jerseys. Carcass discounts were \$38.60/cwt for Jersey steers due primarily to light carcass weights while Holsteins averaged \$6.40/cwt. Average carcass value for Holsteins was \$805.73 while Jerseys were \$357.02. These findings indicate utilizing moderate amounts of roughage in the first two periods of a three phase program for Jersey and Holstein steers does not significantly alter performance or carcass traits while minimally impacting gain efficiency. Because of the slower growth rates of Jersey steers and improved gain efficiency, feeding for a longer period of time to increase carcass weight is anticipated to be economically viable.

Key Words: Dairy Beef, Feedlot, Ruminant

280 Growth of dairy heifers fed wet corn distillers grains ensiled with other feeds. K. F. Kalschur*, A. D. Garcia, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University*.

Two experiments were conducted to evaluate the feeding value of wet corn distillers grains (WDG) ensiled with locally available feeds. The first study evaluated the growth of dairy heifers fed WDG ensiled with soybean hulls (WDGSH). Twenty-four Holstein heifers averaging 184 kg at the start of the 8-wk study were fed either 1) 50% bromegrass hay (BH), 36% corn, 12.7% soybean meal (SBM), and 1.3% mineral and vitamin mix (MV); 2) 50% BH, 17.9% corn, 6.4% SBM, 24.4% WDGSH, and 1.3% MV; and 3) 50% BH, 48.7% WDGSH, and 1.3% MV. Diets provided similar energy and protein concentration (DM basis) at 1.01 Mcal NEg/kg and 16.0% CP; however, percentages of ADF and NDF increased as WDGSH increased in diets. Average daily gain did not differ with increasing WDGSH (1.24, 1.24, and 1.27 kg/d; $P > 0.15$). Withers height tended to increase as WDGSH increased (0.12, 0.16, and 0.16 cm/d; $P < 0.11$). Heart girth, body length, hip height, and body condition score did not differ in heifers fed increasing concentrations of WDGSH. The second study evaluated the growth of dairy heifers fed WDG ensiled with corn stalks (WDGCS). Thirty-four heifers averaging 176 kg were randomly assigned to one of four pens, each containing 8 or 9 heifers for the 8-wk study. Diets were: 1) control diet containing 24% alfalfa hay, 12% grass hay, 16% haylage, 16% corn silage, 12% dried distillers grains, 19% earlage, and 1.5% MV; or 2) WDGCS containing 86% ensiled WDGCS (69% WDG and 31% corn stalks), 12.8% rye straw, and 1.2% MV. Diets were formulated for similar nutrient content: 0.90 Mcal NEg/kg, 18.6% CP, 25% ADF, and 37% NDF (DM basis). Fat content differed between diets (5.1% vs. 10.5%). Average daily gain of heifers fed the control diet was greater than for heifers fed WDGCS (1.28 vs. 1.05 kg/d; $P < 0.04$). Hip height tended to be greater for heifers fed the control diet (0.18 vs. 0.16 cm/d; $P < 0.08$). Dry matter intake and feed efficiency tended to be lower in heifers fed the WDGCS. The use of soyhulls or corn stalks ensiled with wet distillers grains can be an inexpensive alternative to traditional feed sources for dairy heifer rations.

Key Words: Dairy Heifers

281 Increasing inclusion of dried corn distillers grains in dairy cow diets. A. R. Hippen*, K. F. Kalschur, D. J. Schingoethe, and A. D. Garcia, *South Dakota State University*.

Twelve lactating multiparous Holstein cows were used in a replicated 4 × 4 Latin square design with 4-wk periods to determine the effects of increasing dried corn distillers grains (DDGS) in dairy cow diets. The forage portion of the diets was constant and consisted of 28% corn silage and 15% alfalfa hay (DM basis). Dried corn distillers grains were included at 0, 13, 27, or 40% of diet DM. The DDGS replaced corn, soybean meal, extruded soybeans, soybean hulls, and calcium salts of fatty acids as inclusion rates increased. Diets were balanced to provide: 1.69 Mcal NE_L/kg, 21.1% forage NDF, 22.3% ADF, and 6.6% ether extract (DM basis) and maintained a ruminally degradable protein concentration of 10.7% estimated according to 2001 NRC. Crude protein increased from 16.5 to 18.9% in a linear fashion with respect to inclusion of DDGS and estimated metabolizable protein increased from 2.45 to 2.84 kg/d. Dry matter intakes decreased as diet DDGS increased over 13% of diet DM (26.9, 29.9, 26.7, and 25.2 kg/d for 0, 13, 27, and 40% DDGS, respectively; $P < 0.01$). Milk production also decreased (40.7, 41.7, 39.1, and 36.3 kg/d; $P < 0.02$) as diet DDGS concentration increased to greater than 13%. Concentrations of milk protein and lactose did not change with diets; however, milk fat concentrations decreased (3.40, 3.18, 3.19, and 3.10%, $P < 0.04$) as diet DDGS increased. Accordingly, yields of milk fat were decreased (1.39, 1.32, 1.24, and 1.14 kg/d; $P < 0.02$) with increasing diet DDGS. Concentrations of milk urea nitrogen increased (11.1, 12.0, 12.5, and 13.4 mg/dl, $P < 0.01$) as diet DDGS increased. Yields of milk protein were decreased with decreasing milk production ($P < 0.05$). Comparison of differences of least square means indicated that decreases in DMI and milk production were not significant ($P > 0.05$) until DDGS increased above 26% of diet DM. Significant decreases in milk fat concentrations occurred at 13% dietary DDGS. Increasing DDGS above 26% of diet DM in diets of lactating dairy cows decreased DMI and yields of milk and milk components.

Key Words: Distillers Grains, Milk Production, Dry Matter Intake

282 Fatty acid profile, composition, and production of milk from dairy cows fed canola seed. M. W. Chichlowski, J. W. Schroeder, S. E. Bedgar*, C. S. Park, W. L. Keller, and D. E. Schimek, *North Dakota State University*.

The objective was to evaluate the effects of feeding ground canola seed on the fatty acid profile, yield, and composition of milk from dairy cows. Twenty-four multiparous Holstein cows averaging 548.3 ± 11.9 kg body weight and 28 ± 9 d in lactation were randomly assigned to one of two treatments: control or canola, with 14% of the total ration dry matter (DM) as ground canola seed containing 34% lipid. Complete diets were formulated to be 19% crude protein and 1.74 Mcal of net energy for lactation per kg of DM. Diets were composed of corn, corn silage, alfalfa hay and haylage, soybean and blood meal, and vitamins and minerals; the level of corn was decreased and canola meal added to the control diet to replace canola seed. Cows were housed in tie stalls and fed and milked twice daily for 10 wk. Canola did not alter DM intake, weight gain, or body condition score. Milk fat from cows fed canola had a greater percentage of long chain fatty acids (greater than or equal to 18 carbons) and a lower ratio of omega 6 to omega 3 fatty acids. Feeding canola reduced the proportion of short and medium chain fatty acids (less than 18 carbons). Milk fat from cows fed canola had a greater percentage of transvaccenic acid and tended to have a higher proportion of *cis*-9, *trans*-11 conjugated linoleic acid. Actual and 3.5% fat-corrected milk yield and somatic cell count were not different between treatments. The milk component percentages for fat, protein, and solids-not-fat were lower for canola-fed cows, but total yield of these components was not different between diets. Urea nitrogen was lower in milk from cows fed canola. Serum glucose, urea nitrogen, and nonesterified fatty acids were not altered, but serum triglycerides were higher in cows fed canola. Ammonia and total volatile fatty acids tended to be lower in ruminal fluid from the treatment group; pH was unchanged. Feeding canola seed to lactating dairy cows altered the fatty acid profile in milk fat without affecting milk yield.

Key Words: Canola Seed, Dairy Cow, Milk Fatty Acids

283 Creep feed protein level and weaning age affects replacement beef heifer performance. W. J. Sexten*, D. B. Faulkner, and J. M. Dahlquist, *University of Illinois*.

Sixty-four Simmental x Angus heifer calves were utilized in a 2 x 2 factorial arrangement to determine the effects of creep feed protein level and weaning age on performance, reproduction and first lactation milk production of replacement heifers. Weaning occurred at 89 ± 1.6 (EW) or 232 ± 1.8 (NW) days of age while creep diets were either 12% or 17% CP. All heifers were given *ad libitum* access to the 12% CP diet from early weaning until dietary treatment initiation. Dietary treatments began 57 days after early weaning when cattle were turned out onto mixed pastures and concluded after an 84-day feeding period at normal weaning. Heifers were given *ad libitum* access to respective creep diets for one month after normal weaning. A weaning age by diet interaction was observed for weight at normal weaning and feeding period ADG ($P < 0.05$). Providing EW heifers with additional protein increased weight at normal weaning and improved ADG from 1.18 to 1.26 kg/d, however, additional protein fed to NW heifers decreased performance from 1.37 to 1.22 kg/d. Daily supplemental DMI was 2.12 kg/d higher ($P < 0.05$) for EW heifers. Early weaned heifers were lighter ($P < 0.10$) from puberty through breeding, however by palpation no BW differences were observed. Despite lighter pubertal weights, more ($P < 0.05$) EW heifers (81.3%) were pubertal at eight months of age than NW heifers (59.4%). No differences were observed at 10 or 12 months of age. Pregnancy rates tended ($P < 0.10$) higher for EW (90.0%) than NW (74.2%). Diet did not influence BW at puberty through calf early weaning, percent of heifers pubertal by eight, ten or twelve months of age or reproductive rates ($P > 0.05$). Milk production and calf performance were not influenced ($P > 0.05$) by weaning age or creep protein level. Creep feed protein level does not influence performance, reproduction or first lactation milk production of replacement heifers. Early weaning reduced heifer size until breeding, increased percentage of replacements cycling at an early age and improved pregnancy rates without influencing milk production.

Key Words: Replacement Heifer, Dietary Protein, Weaning Age

284 Influence of excess crude protein in creep feed of replacement beef heifers calving first at 18 or 24 months of age. W. J. Sexten*, D. B. Faulkner, F. A. Ireland, and T. G. Nash, *University of Illinois*.

One hundred thirty-six heifer calves nursing dams were utilized in a completely randomized block design to determine the effects of creep feed protein level on performance, reproduction and first lactation milk production. Cattle were blocked by location, which included the effects of breed, calving age, and management environment. In southern Illinois, 100 Simmental x Angus heifers were managed to calve first at 18 months of age and received dietary treatments for 126 days. Thirty-six Angus heifers in central Illinois were managed to calve first at 24 months of age and consumed creep treatments for 84 days. Creep diets were either 12% or 17% CP and consisted primarily of cracked corn. Distillers dried grains with solubles were added to increase CP levels. The location x diet interaction was not significant ($P > 0.05$) so data were pooled. Creep feed protein level did not influence preweaning performance ($P > 0.05$). Preweaning ADG was not different between 12% (1.27 kg/d) and 17% (1.26 kg/d) diets. Creep diet did not affect breeding, palpation or calving weights ($P > 0.05$). Reproductive performance was not influenced by creep diet ($P > 0.05$). Additional protein in creep feed tended ($P < 0.10$) to depress first lactation milk production. Milk production estimates for heifers fed 12% creep were 5.60 kg/d while heifers fed additional protein in creep produced 4.91 kg/d. Subsequent calf performance was not impacted by dam's creep diet. Providing excessive CP to replacement heifers through creep feeding did not enhance performance and may negatively impact future milk production.

Key Words: Replacement Heifer, Dietary Protein, Creep Feed

285 In vitro procedure for estimating dry matter and protein disappearance of grains in ruminants. J. R. Benton*, T. J. Klopfenstein, G. E. Erickson, and C. N. Macken, *University of Nebraska*.

A series of studies was conducted to develop an in vitro procedure to estimate DM and CP disappearance of dry-rolled (DRC) or high-moisture corn (HMC). Samples were inoculated with a 2:1 dilution of buffer to rumen fluid. After incubation, samples were centrifuged, supernatant

removed, and rinsed twice. Residues were weighed to calculate percent of IVDM. Undegradable protein (UIP, as % of CP) of grain was calculated from residue protein. In Exp. 1, centrifuge speed and time were tested for separation of undigested feed from microbes. Treatments were two speeds (150 or 300 g) and two times (5 or 15 min). There was an interaction between speed and time ($P < 0.01$) for DRC. As speed increased from 150 to 300 g at 5 min, UIP increased and at 15 min, UIP decreased ($P < 0.01$). As time increased from 5 to 15 min at 150 g, UIP increased and at 300 g, UIP decreased ($P < 0.01$). Exp. 2 was like Exp. 1 except that times were 10 or 15 min. UIP increased for HMC when speed increased ($P = 0.05$) and for DRC and HMC when time increased ($P < 0.02$). Exp. 3 investigated methods to remove supernatant (pouring or using suction) and number of rinses (1 to 4) of the feed. The two rinse methods were not different ($P > 0.30$). There was no difference in protein content of the supernatant after two rinses ($P > 0.05$) suggesting that two are sufficient to separate feed and microbes. Exp. 4 evaluated incubation times. Samples were incubated for 0, 12, 24, 36, 48, 72 or 96 h. At 96 h, UIP for DRC (7.9%) and HMC (3.7%) was lower than literature in situ data. It was hypothesized that pH of the media was too high. Exp. 5 evaluated effects of pH using only McDougall's buffer (pH = 6.9) or low pH (5.8) with citric acid addition. When pH was low, UIP increased ($P < 0.01$) from 50.4 to 77.2% or 31.2 to 48.7% for DRC and 47.4 to 67.1% or 25.4 to 49.0% for HMC at 30 or 72 h of incubation, respectively. Results suggest the buffer pH should be adjusted to 5.8 and samples should be centrifuged at 150 g for 10 min and rinsed twice using a suction method to estimate DM and CP disappearance of grains.

Key Words: In Vitro, Protein Digestion, Ruminants

286 The effect of rumen degradable and undegradable protein supplementation in barley-based high-grain finishing diets on feedlot performance and carcass traits of beef steers. B. W. Pamp*, M. L. Bauer, and G. P. Lardy, *North Dakota State University*.

One hundred and forty-one crossbred steers (442.0 ± 7.3 kg initial BW) were allotted randomly to one of four dietary treatments (6 pens/treatment) in a CRD and fed for 89 days. The objective in this experiment was to evaluate effect of rumen degradable protein (RDP) and rumen undegradable protein (RUP) on performance and carcass traits of finishing steer calves fed barley-based diets. Initial weights were determined by a 3-day average during which steers were fed a common diet at 2% of BW. Dietary treatments and diet formulations were arranged in a 2 x 2 factorial. Factors were RDP (+/-) and RUP (+/-). Diets were formulated such that +RDP added 1% CP from urea and +RUP added 1% CP from the feather meal/blood meal combination. The basal diet was formulated to contain (DM basis) 83% barley, 5% alfalfa hay, 5% corn silage, 5% de-sugared molasses, 2% supplement, 27.5 mg/kg monensin, and 11 mg/kg tylosin, and was formulated to contain a minimum of 12.5% CP, 0.7% Ca, 0.3% P, and 0.7% K. Steers were fed once daily and weighed at 28 d intervals. Final weight was not affected by dietary treatment ($P \geq 0.18$); however, ADG tended ($P = 0.08$) to increase with RUP supplementation. The dietary treatments had no effect on DMI ($P \geq 0.74$), gain efficiency ($P \geq 0.15$), or hot carcass weight ($P \geq 0.18$). There was a RDP x RUP interaction ($P = 0.02$) for ribeye area which increased with RUP supplementation when RDP was not supplemented (87.9 vs 78.2 ± 1.4 cm²); however, when RDP was supplemented RUP supplementation did not effect REA (87.9 vs 81.7 ± 1.4 cm²). Supplemental RUP also decreased ($P = 0.01$) calculated yield grade (2.13 vs 2.44 ± 0.05). Supplemental RDP did not improve performance or carcass characteristics ($P \geq 0.35$). It appears that RDP may be adequate in barley-based finishing diets; however, supplemental RUP may improve performance in steers fed barley-based high grain diets.

Effect of protein degradability on performance and carcass characteristics of finishing steers

Item	-RDP		+RDP		SEM	Effect		
	-RUP	+RUP	-RUP	+RUP		RDP	RUP	RDPxRUP
ADG, kg/d	1.30	1.43	1.36	1.40	0.05	0.72	0.08	0.39
DMI, kg/d	10.48	10.61	10.72	10.64	0.40	0.74	0.96	0.81
ADG/DMI, dg/100 kg	12.39	13.50	12.73	13.33	0.57	0.89	0.15	0.66
Yield grade	2.54	2.07	2.33	2.18	0.12	0.69	0.01	0.19

Key Words: Degradable Protein, Undegradable Protein, Barley

287 Influence of degree of barley processing on digestive functions in steers. W. L. Bengochea*, M. L. Bauer, G. P. Lardy, T. C. Gilbery, and S. A. Soto-Navarro, *North Dakota State University*.

Fourteen ruminally, duodenally, and ileally cannulated Holstein steers (328 ± 43 kg initial BW) were used in a completely randomized design to evaluate the effects of barley processing (particle size) on site of digestion and ruminal fermentation. Treatments consisted of 1) coarse rolled barley (2770 μm particle size), 2) medium rolled barley (2127 μm particle size), and 3) fine rolled barley (1385 μm particle size). Diets were 40% barley, 33.75% corn silage, 15% hay, 6.25% supplement, and 5% desugared molasses (DM basis). Steers were allowed free access to water. Steers were stratified by weight and assigned randomly to one of the treatments. Linear and quadratic contrast coefficients were constructed based on mean particle size. Periods consisted of 14-d adaptation followed by 7-d collection. Total fecal output was collected daily and subsampled. Duodenal and ileal samples were taken every 4 h for 3d to represent each even hour in a 24-h period. Cobalt-EDTA was administered on d 6 to determine liquid dilution. Ruminal fluid was collected on d 6 at 2, 0, 2, 4, 6, 8, 10, 12 h post feeding. In situ bags were placed in the rumen at 0, 2, 4, 8, 12, 36, 48, and 72 h to measure barley fermentation rate. Organic matter, CP, NDF, and ADF digestibilities were not affected ($P > 0.10$) by barley processing. However, fecal starch output linearly decreased ($P < 0.05$) and total tract starch digestibility linearly increased ($P < 0.05$) with finer barley processing. In situ DM, CP, starch disappearance rate, starch soluble fraction, and extent of starch digestion increased linearly ($P < 0.05$) with finer processing. There was a time x treatment interaction for total VFA concentration; at 2 h after feeding the fine processing was greater than the medium or coarse. Ruminal pH quadratically increased ($P < 0.05$) with increasing degree of processing. Finer barley processing degree improves characteristics of starch digestion in backgrounding diets.

Key Words: Processing, Barley, Starch

288 Effect of particle size and moisture concentration of steam-flaked corn in finishing cattle diets. J. J. Sindt*, J. S. Drouillard, M. A. Greenquist, E. R. Loe, and S. P. Montgomery, *Kansas State University*.

Two finishing experiments evaluated the effect of flake particle size and moisture concentration in finishing heifer diets. In Exp. 1, 89 heifers (BW = 350 kg) were stratified by BW, assigned to 12 pens (6 per treatment) and used in a 108-d finishing experiment. Diets contained 76% steam-flaked corn (DM basis) that was processed to 0.335 kg/L. Treatments consisted of mixing flaked corn for 0 (CON) or 15 (FINE) min prior to addition of other dietary ingredients. Particle sizes were 4700 μ and 3300 μ for the flaked grains and 2320 μ and 2250 μ, respectively, for CON and FINE diets. Complete diets were mixed for 3 min prior to feeding. Heifers fed CON tended ($P = 0.12$) to consume more feed but ADG and ADG/DMI were similar (DMI = 9.30 and 8.81 kg/d, ADG = 1.17 and 1.14 kg, and ADG/DMI = 0.127 and 0.131, for CON and FINE, respectively). Carcass characteristics were similar for cattle fed CON and FINE except that heifers fed CON had more ($P < 0.01$) kidney, pelvic, and heart fat than heifers fed FINE. In Exp. 2, 96 crossbred heifers (BW = 389 kg) were stratified by BW, assigned to 12 pens (6 per treatment) and used in an 82-d finishing experiment. Heifers were offered ad libitum access to diets containing 73% steam-flaked corn (DM basis). Dietary treatments consisted of steam-flaked corn that contained 18 (LOW) or 36% (HIGH) moisture. Water was added to corn (20% wt/wt) and tempered for 12 h to produce the HIGH treatment. Both LOW and HIGH treatments were steam conditioned for 45 min and flaked to 0.335 kg/L. Heifers fed HIGH consumed less DM ($P < 0.05$; 8.59 and 8.00 kg for LOW and HIGH, respectively), had lower ADG ($P < 0.05$; 1.49 and 1.37 kg/d for LOW and HIGH, respectively) but had comparable efficiencies. Cattle fed HIGH deposited ($P < 0.01$) more subcutaneous fat and tended ($P = 0.11$) to have more USDA Yield Grade 3 carcasses. Reducing particle size by excessive mixing had minimal impact on animal performance. Moisture content of flaked grains may be an important determinant of finishing performance.

Key Words: Maize, Flaking, Particle Size

289 Effect of corn moisture of ensiled early-harvested and reconstituted field-dried corn and degradable intake protein concentration on finishing cattle performance. J. R. Benton*, C. N. Macken, K. J. Vander Pol, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska-Lincoln*.

Four hundred eighty steers (BW = 337 kg) were used to compare the feeding value of ensiled, earlyharvested corn (EHC) at 26 or 33% moisture (26HMC or 33HMC), ensiled, reconstituted field-dried corn (RFDC) at 26 or 33% moisture (26RECON or 33RECON) and field-dried corn (DRC), all of the same hybrid. Cattle performance, carcass characteristics and degradable intake protein (DIP) concentration were evaluated. Steers were stratified by weight, allotted to one of 60 pens and fed one of 15 finishing diets. The treatment design was a 5x3 factorial with factors being corn type (26HMC, 33HMC, 26RECON, 33RECON or DRC) and DIP balance (negative, zero or positive). The NRC (1996) model was used to calculate the DIP balances. Addition of urea was required at 0, 0.45 or 0.90% of the diet (DM basis). The final diets contained 69% corn, 18% corn bran, 5% grass hay, 3% tallow and 5% dry supplement (DM basis). No significant interactions occurred between corn type and DIP balance. Within corn type, EHC and RFDC were not different but 26 and 33% moisture were different. Steers fed diets containing 33HMC or 33RECON gained 6.3% faster ($P < 0.05$) and were 9.4% more efficient ($P < 0.01$) than steers fed diets containing DRC. Steers fed diets containing 26HMC and 26RECON had intermediate performance. Within DIP balance, steers fed diets supplemented with urea were 6.6% more efficient (quadratic response, $P < 0.02$) and gained 6.1% faster (linear response, $P < 0.01$) than steers receiving no supplemental urea. Diets containing no urea were deficient in DIP. Results indicated that RFDC had the same feeding value as EHC when ensiled at the same moisture. Increasing the moisture of either corn enhanced the feeding value when fed in finishing diets. Supplementing diets with 0.45% urea was sufficient to meet DIP requirements and have a zero DIP balance due to corn high in protein (CP = 10.5%). However, supplementation with urea above 0.45% was not beneficial.

Key Words: Cattle, Maize, Protein Degradation

290 Effect of forage level and corn processing on diet digestibility and feedlot performance. M. A. Gorocica-Buenfil* and S. C. Loerch, *The Ohio State University*.

One digestion and one performance trial were conducted to evaluate the effect of two forage levels (High=18.2% and Low=5.2% of corn silage in the diet, DM basis) and corn processing (whole vs. cracked) on diet digestibility and feedlot performance. 168 Angus-based steers were blocked by weight and allocated to a 3x2 factorial arrangement of treatments to one of the following treatments: High Forage-Cracked Corn (HFCC); High Forage-Shift Corn (corn was fed whole during the first half of the feeding period, then switched to cracked corn for the rest of the trial, HFSC); High Forage-Whole Corn (HFWC); Low Forage-Cracked Corn (LFCC); Low Forage-Shift Corn (LFSC); Low Forage-Whole Corn (LFWC). An interaction between forage level and grain processing treatment occurred ($P < .10$) for daily DMI during the total trial. HFCC steers had 7% greater DMI than those fed HFWC, whereas for the low forage diets grain processing did not affect DMI. No interactions ($P > .10$) between forage level and corn processing were found for ADG and FE. For the total feeding period, ADG, FE, percentage of carcasses grading Choice, and carcass Yield Grade were not affected ($P > .10$) by corn processing. An apparent interaction between days on feed and feedlot performance was observed. Cattle with fewer days on feed benefited from corn processing while cattle with longer days on feed had greater ADG and FE when corn was fed whole. Due to the experimental design, this interaction could not be evaluated statistically; therefore, further research on this apparent interaction is warranted. The HFCC, HFWC, LFCC and LFWC diets were fed in a digestion trial with 16 steers. No interaction ($P > .10$) between forage level and corn processing was detected on diet digestibility. Forage level and corn processing did not affect ($P > .10$) diet DM, OM, starch, CP, NDF and ADF digestibility. Less than 5% of the whole corn kernels fed appeared in feces, and starch content in the feces was not different between cracked and whole corn fed steers. Processing corn did not improve starch digestion or feedlot performance.

Key Words: Corn Processing, Digestibility, Feedlot

291 Evaluation of corn hybrid traits and relationship to efficiency of use by feedlot cattle. S. L. Jaeger¹, G. E. Erickson^{*1}, C. N. Macken¹, T. J. Klopfenstein¹, D. S. Jackson¹, and W. A. Fithian², ¹University of Nebraska-Lincoln, ²J.C. Robinson Seed Co.

Seven hybrids (GH-9164, 1; GH-9235, 2; GH-9230, 3; 33B51, 4; 33P67, 5; GH-8562, 6; and GH-9533, 7) were produced and fed under identity-preserved protocols to evaluate different kernel characteristics and subsequent feedlot cattle performance. At harvest, each grain was sampled in 4 replications (field = 2; rep = 2) for an estimate of variation within hybrid and for analysis. Stenvert hardness tests related to grinding, 1000 kernel weight, % starch, in vitro starch disappearance, in situ DM disappearance, and others were conducted. Steers (n = 224; BW = 276 kg) were assigned randomly to 28 pens with 4 pens per corn hybrid treatment. Dietary treatments were 66% dry-rolled corn hybrid, 20% wet corn gluten feed, 10% corn silage, and 4% supplement. Cattle were fed 167 d and averaged 1.3 cm fat depth and Small⁴⁶ marbling at marketing. No differences (P > 0.10) were detected for ADG, DMI, BW, or carcass characteristics among hybrids. However, ADG:DMI was different (P < 0.01) across hybrids. Cattle fed hybrid 6 were 9.5% more efficient than cattle fed hybrid 3 and 5.7% more efficient than cattle fed 3 other intermediate hybrids (2, 4, 5). Feed efficiency was correlated (P < 0.05) with Stenvert soft particle height (r = 0.85), Stenvert time to grind (r = -0.83), and 1000 kernel weight (r = 0.81). In situ DM disappearance for 16 h (r = 0.72) and 24 h (r = 0.71) were also correlated (P < 0.10) to ADG:DMI. Differences exist across hybrids when fed as dry-rolled corn to feedlot cattle and tests indicate larger, softer kernels appear superior.

Hybrid	1	2	3	4	5	6	7	SEM
ADG:DMI	0.179 ^{ab}	0.175 ^{bc}	0.169 ^c	0.174 ^{bc}	0.175 ^{bc}	0.185 ^a	0.179 ^{ab}	0.002
Stenvert, soft height	7.59 ^a	6.88 ^c	6.29 ^d	6.79 ^c	6.21 ^d	7.63 ^a	7.17 ^b	0.08
Stenvert time, s	7.6 ^{ab}	7.8 ^{bc}	9.7 ^e	8.1 ^c	8.7 ^d	7.3 ^a	7.9 ^{bc}	0.1
1,000 kernel weight, g	318.2 ^c	316.9 ^c	314.6 ^{cd}	310.9 ^d	326.2 ^b	344.3 ^a	340.9 ^a	1.7

a,b,c,d,e Means with different superscripts differ (P < 0.05).

Key Words: Maize, Kernel Traits, Beef Cattle

292 Stocking rate and supplementation effects on pasture finished steers. E. Felton, T. Romanczak*, and W. Bryan, West Virginia University.

A 2 yr study was conducted to evaluate the effects of stocking rate (SR) and supplementation (SUP) on the performance of beef steers finished on pasture. The SUP was a fibrous byproduct/corn based product containing 12.5% CP, 34.0% NDF, 7.0% EE, and 79% TDN. Forty-eight yearling steers were used each yr, with 12 steers being preselected for early removal. Steers grazed one of 12, one ha plots at a SR of 4 steers/ha without SUP from early spring until mid summer. Stocking rate was reduced by two steers on half of the grazing plots when pasture height averaged 9.9 cm and SUP at 1.25% of BW was begun on half of each SR group. Thus, plots were stocked at either 2 or 4 steers/ha with or without SUP to yield 4 treatments. Before treatment initiation (reduction in SR and SUP) treatment designation had no effect (P > 0.05) on beginning BW (318 kg), treatment initiation BW (398 kg), or ADG (1.36 kg/d). There were no interactions between SR and SUP strategy on growth performance thus only main effects are presented. Final BW and overall ADG (P < 0.01) were increased by reducing SR (467 vs 505 kg; 0.96 vs 1.17 kg/d) and SUP (449 vs. 522 kg, 0.54 vs 1.10 kg/d), respectively. Average daily gain since treatment initiation was also increased by reducing SR (0.67 kg vs 0.97 kg; P < 0.01). Supplementation increased quality grade (QG: Se⁹⁴ vs Se⁹²; P < 0.01), hot carcass weight (HCW: 509 vs 652 kg; P < 0.01), yield grade (YG: 2.3 vs 2.7; P < 0.01), rib eye area (REA: 57 vs 69 cm²; P < 0.01), and dressing percentage (DP: 52 vs 57%; P < 0.01). A decrease in SR increased QG (Se⁷² vs Se²³; P < 0.05), HCW (612 vs 548 kg; P < 0.01), REA (66 vs 61 cm²; P < 0.01), and DP (55 vs 53%; P < 0.01). There was an interaction between SUP and SR for kidney, pelvic, & heart (KPH) fat. Steers stocked at 4/ha without SUP had the least KPH (1.6 vs 2.2%) as compared to the other treatment groups. These data suggest that a reduction in SR and SUP can be used to pasture finish steers by two years of age.

Key Words: Carcass, Pasture, Beef

293 Factors contributing to carcass value and profitability in early weaned Simmental steers. N. A. Pyatt^{*1}, L. L. Berger¹, D. B. Faulkner¹, and P. M. Walker², ¹University of Illinois, ²Illinois State University.

Early-weaned steers (n = 192, 3/4 Simmental or greater) of known genetics were individually fed in a four-year study to determine performance and carcass factors explaining variation in carcass value and profitability. Steers were weaned at 88.0 ± 1.1 d and fed a high concentrate diet (\$108.99/T) for 84.5 ± 0.4 d prior to allotment. Calves were implanted with Synovex[®] C at weaning and successively with Synovex[®] S and Revalor[®] S. Steers consumed a 90% concentrate diet (\$98.93/T), consisting primarily of whole shelled corn and corn silage, for 249.7 ± 0.7 d and harvested at 423.3 ± 1.4 d of age. Five-year price data were collected for feedstuffs, dressed beef, and grid premiums and discounts. Average dressed beef price was \$110.67/45.4 kg. Premiums (\$/45.4 kg) were given for Prime (\$5.62), premium Choice (\$1.50), yield grades (YG) 1 (\$2.46), 2A (\$1.31) and 2B (\$1.11). Discounts (\$/45.4 kg) were given for Standard (-\$16.85), Select (-\$8.90), YG 3A (-\$0.12), 3B (-\$0.19), 4 (-\$14.16) and 5 (-\$19.56), and hot carcass weight (HCW) extremes (409-431 kg, -\$0.64; 432-454 kg, -\$11.39; > 454 kg, -\$19.71). Input costs included annual cow costs (\$327.77), veterinary/medical and labor (\$35/hd), feed markup (\$22/T), yardage (\$0.25/hd/d) and interest (10%). Dependant variables were carcass value and profit per steer. Independent variables were yearling weight EPD, marbling EPD, daily DMI, ADG, feed efficiency, HCW, 12th rib fat, calculated YG and marbling score (MS). Carcass value was correlated (P < 0.05) with yearling weight and marbling EPD, DMI, ADG, feed efficiency, HCW and MS. Carcass weight, MS and YG accounted for over 79% of the variation in carcass value among steers; explaining 57, 12 and 10%, respectively. Profit was correlated (P < 0.05) with DMI, ADG, feed efficiency, HCW and MS. Marbling score, DMI, ADG, YG and HCW accounted for over 77% of the variation in profit among steers; explaining 30, 14, 12, 12 and 9%, respectively. Carcass weight was the most critical factor contributing to carcass value while carcass quality was the leading factor affecting steer profitability.

Key Words: Carcass Value, Profitability, Early-Weaning

294 Phosphorus requirement of finishing heifers. B. G. Geisert*, G. E. Erickson, T. J. Klopfenstein, and C. N. Macken, University of Nebraska.

The objective of this experiment was to determine the P requirement of finishing cattle. It is important to determine the P requirement for finishing cattle because not supplying adequate P in the diet may hinder performance, however overfeeding P potentially leads to environmental problems associated with excess P in surface waters. This experiment used 60 (initial BW = 279 kg) large framed, crossbred heifers. Treatments consisted of 5 levels of dietary P (0.10, 0.17, 0.24, 0.31 and 0.38% P of DM) achieved by feeding one base diet (0.10% P DM basis) of 50% course brewers grits, 15% high moisture corn, 15% corn bran, 10% sorghum silage, 5% tallow and 5% supplement. Monosodium phosphate was top-dressed to obtain the other 4 levels. Cattle were weighed and blood samples were taken on day 0 and every 28 days throughout the trial. At slaughter, the metacarpal, first phalanx, and second phalanx bones were removed from the right foreleg. Cattle fed the 0.10% P treatment had significantly lower DMI and lower ADG (P < 0.01) but no difference in feed efficiency. There were no differences in marbling score or 12th rib fat thickness. There were no significant differences among treatments in plasma P concentration on day 0 (P > 0.30), with an average P concentration of 7.12 mg/dL. There was a significant treatment by time interaction (P < 0.01) for heifers fed at the 0.10 level at day 28 through slaughter. Plasma P concentration for treatment 0.10 on day 28, 56, 84, 112, 140, and 180 were 4.5, 3.9, 4.8, 5.3, 4.3, and 4.9 mg/dL respectively. Heifers fed 0.10% P had lower (P = 0.01) phalanx bone ash weight at slaughter when compared to the other treatments. When nonlinear analysis was conducted on ADG, the P requirement was 0.115% with a 95% confidence interval of 0.104 and 0.127% P of diet DM. Based on these observations, we suggest that the P requirement for finishing heifers is within these values. These results indicate that corn-based finishing rations supply adequate P levels to finishing cattle without additional supplementation.

Key Words: Phosphorus, Requirement, Cattle

295 Evaluation of feeding varying levels of wet distillers grains as compared to dry distillers grains to finishing steers. K. S. Mateo*, K. E. Tjardes, C. L. Wright, and T. J. Koger, *South Dakota State University Department of Animal & Range Sciences*.

A two-year study was conducted to determine the effect of feeding different levels of dry distillers grains (DDG) and wet distillers grains (WDG) on the performance of finishing cattle. For each yr, 120 steers (343 ± 10 kg) were weighed, randomly allocated to 15 pens, and assigned to one of five treatments: 1) corn-soybean meal base diet (CON); 2) 20% DDG; 3) 20% WDG; 4) 40% DDG; or 5) 40% WDG. All the treatment diets contained 10% hay, 4% molasses, 2% supplement and varying levels of cracked corn. Steers received treatment diets for 138 and 129 d for yr 1 and 2, respectively. Body weight was recorded prior to feeding at the start of the trial and every 28d. At the end of the trial, steers were harvested at a commercial facility and carcass data was collected. No treatment yr interactions occurred, thus data were pooled over the 2 yr. Steers fed distillers grains had greater ($P < 0.01$) overall DMI compared to steers fed CON. Steers fed DDG had greater ($P < 0.05$) overall DMI compared to steers fed WDG. Overall ADG was similar across all treatments but there was a quadratic effect ($P < 0.05$) for feed efficiency (0.168, 0.160, 0.162, 0.162, and 0.170 for CON, 20% DDG, 20% WDG, 40% DDG, and 40% WDG, respectively). Results of pooled carcass data showed that 12th rib fat was greater ($P < 0.01$) for steers fed distillers grains compared to CON (1.3, 1.5, 1.6, 1.5, and 1.4 cm for CON, 20% DDG, 20% WDG, 40% DDG, and 40% WDG, respectively). Steers fed distillers grains had greater ($P < 0.05$) yield grades compared to CON steers. There was a quadratic effect of marbling; steers fed 20% DDG and 20% WDG had higher ($P < 0.05$) marbling scores compared to steers fed CON, 40% DDG and 40% WDG. Dressing percentage, hot carcass weight, ribeye area, and percent kidney, pelvic, and heart fat were similar across all treatments. In conclusion, steers fed DDG and WDG at 20 and 40% of the diet DM had similar performance. However, overall DMI and yield grades were greater for steers fed distillers grains compared to CON.

Key Words: Distillers, Soybean Meal, Finishing Steers

296 Evaluation of feeding wet distillers grains, dry distillers grains and blood meal to growing steers. K. S. Mateo, K. E. Tjardes*, and C. L. Wright, *South Dakota State University Department of Animal & Range Sciences*.

A two-year study was conducted to determine the effect of feeding different protein/energy sources on the performance of feeder cattle. During yr 1 (Y1), 128 steers (230 ± 18 kg) were weighed, randomly allocated to 16 pens, and assigned to one of four treatment diets: 1) 20% soybean meal and corn (SBM); 2) 20% dried distillers grains (DDG); 3) 20% wet distillers grains (WDG); or 4) 20% blood meal, oil and corn (BM). In Y1, steers were fed a backgrounding diet that consisted of 74% alfalfa/grass hay, 4% molasses and 2% supplement for the first 28 d and a grower diet that consisted of 50% alfalfa/grass hay, 24% corn, 4% molasses and 2% supplement for the remaining 56 d. During yr 2 (Y2), 160 steers (243 ± 18 kg) were weighed, randomly allotted to 16 pens, and assigned to one of the four growing diets used in Y1 throughout the entire 57 d trial. Body weight was recorded prior to feeding at the start of the trial and every 28 d for both years. During the first 28 d of Y1, steers fed WDG had a greater ($P < 0.05$) DMI compared to steers fed the other treatment diets (5.17, 5.18, 5.67, 4.88 kg DM/d for SBM, DDG, WDG, and BM, respectively). Steer ADG was not affected by treatment; however, steers fed BM were more efficient (G:F; ($P < 0.05$) than steers fed SBM and WDG, with DDG being intermediate (0.24, 0.25, 0.23, and 0.27 for SBM, DDG, WDG, and BM, respectively). During the final 56 d and the overall trial for Y1, ADG, DMI and G:F of steers were not significantly different. During the first 28 d in Y2, steer DMI was not affected by treatment. Steer ADG was greater ($P < 0.05$) for BM compared to SBM, with DDG and WDG being intermediate (1.62, 1.65, 1.74, and 1.84 kg/d for SBM, DDG, WDG, and BM, respectively). This resulted in steers fed BM having greater ($P < 0.05$) G:F ratio compared to SBM and DDG, with WDG being intermediate. Steers fed BM and WDG had greater ($P < 0.05$) overall ADG and G:F compared to steers fed the SBM, but did not differ from steers fed DDG. In conclusion, feeding BM and WDG may improve performance of growing steers.

Key Words: Distillers, Soybean Meal, Performance

297 Urea inclusion in forage based diets containing dried distillers grains in excess of the metabolizable protein requirement. L. A. Stalker*, T. J. Klopfenstein, D. C. Adams, and G. E. Erickson, *University of Nebraska*.

Two 84-d experiments evaluated supplemental degradable intake protein (DIP) requirements of growing heifers consuming forage based diets containing dried distillers grains (DDG). Basal diets were formulated to be at least 124 g/d deficient in DIP but contained sufficient DDG to supply at least 97g/d excess metabolizable protein (MP). In Exp. 1, 60 crossbred heifers (278 ± 16 kg) were stratified by weight then assigned randomly to treatments. Treatments were designed to correct 0, 33, 67, 100 and 133% of the 1996 NRC predicted DIP deficiency of the base diet by addition of urea. Heifers were individually fed in Calan electronic gates for ad libitum consumption of a 58% ground corn cobs and 12% sorghum silage diet. The remaining 30% of the diet was DDG replaced with the appropriate amount of urea. Urine was collected from each heifer for 5 consecutive d and assayed for allantoin and creatinine concentrations. Ratio of allantoin to creatinine (A:C) was assumed indicative of microbial crude protein production. In Exp. 2, 48 crossbred heifers (205 ± 20 kg) were stratified by weight then assigned randomly to one of eight pens. Pens were then assigned randomly to supplement treatments. Heifers were fed for ad libitum consumption of grass hay (54% TDN, 7.4% CP) and supplemented daily with either 1.4 kg DDG/heifer or 1.4 kg DDG plus 45g urea/heifer. This was the amount of urea required to meet the 1996 NRC predicted DIP requirement. Urine was collected from each heifer for 3 consecutive d, composited by animal, and analyzed as described for Exp. 1. In Exp. 1, heifer ADG ($P = 0.77$), DMI ($P = 0.95$), G:F ($P = 0.54$), and A:C ratio ($P = 0.84$) were similar among treatments. Likewise, in Exp. 2, heifer ADG ($P = 0.17$), DMI ($P = 0.76$), G:F ($P = 0.33$), and A:C ratio ($P = .98$) were similar between treatments. We attribute the lack of differences in both experiments to recycling of endogenous urea and interpret these results to indicate that supplemental DIP is not necessary when DDG are fed in excess of the MP requirement in forage based diets.

Key Words: Cattle, Dried Distillers Grains, Urea Recycling

298 Effects of cooked molasses blocks and fermentation or seaweed extract inclusion on intake, digestion, and microbial efficiency in steers fed low-quality hay. J. L. Leupp*, J. S. Caton, G. P. Lardy, S. A. Soto-Navarro, and M. L. Bauer, *North Dakota State University*.

Five ruminally, duodenally, and ileally cannulated steers (376 ± 8.1 kg initial BW) were used in a 5×5 Latin square to evaluate effects of cooked molasses block supplementation and inclusion of fermentation (*Aspergillus oryzae*) or seaweed (*Ascophyllum nodosum*) extract on intake, site of digestion, and microbial efficiency. Diets consisted of switchgrass hay (6.0% CP) offered ad libitum and one of three molasses blocks (0.341 kg/d; half at 0600 and half at 1700). Treatments were: no block (CON); block with no additive (40.5% CP; POS); block plus fermentation extract bolused directly into rumen (2.0 g/d; F); fermentation extract included in block (2.0 g/d; FB); and seaweed extract included in block (10 g/d; SB). Steers were adapted to diets for 14 d followed by a 7-d collection period. Hay OMI (8.1 vs 7.7 ± 0.5 kg/d) and total OMI (8.5 vs 7.7 ± 0.5 kg/d) increased ($P \leq 0.06$) in steers consuming block compared with CON. Apparent and true ruminal OM digestibility increased ($P = 0.05$) with block consumption. Steers consuming SB had higher true ruminal OM digestibility compared to POS (53.8 vs $50.2 \pm 1.9\%$; $P \leq 0.09$). Apparent ruminal CP digestibility increased with block supplementation compared with CON (39.1 vs $33.5 \pm 2.8\%$; $P = 0.03$). Total tract NDF and ADF digestibilities were increased ($P = 0.05$) with block supplementation, and SB increased ($P \leq 0.05$) digestion of these fiber fractions above POS. Addition of fermentation extract did not affect ($P \geq 0.34$) intake or digestion. Treatments did not alter ruminal pH, total VFA, or individual VFA proportions ($P > 0.5$); however, ruminal ammonia increased ($P = 0.01$) with block supplementation. No treatment effects were observed ($P > 0.10$) for microbial efficiency. Block supplementation increased intake and use of seaweed extract appears to have beneficial effects on forage digestibility.

Key Words: Fermentation Extract, Seaweed Extract, Supplementation

299 Effect of corn bran and steep inclusion in finishing diets on digestibility. K. M. Sayer*, G. E. Erickson, T. J. Klopfenstein, and T. W. Loy, *University of Nebraska*.

A metabolism trial was conducted to evaluate the effect of corn bran and steep inclusion in finishing diets on digestibility. Eight ruminally cannulated crossbred heifers were evaluated in a replicated 4 x 4 Latin Square. An in-situ trial was also conducted during the final period with incubation time points of 0, 12, 24, 48, and 96 h. Dry rolled corn (DRC) was evaluated for DM disappearance rate, and corn bran was evaluated for NDF disappearance rate in each of the four diets. All diets included 15% corn silage, 5% supplement and DRC. Treatments included Control (CON), 30% Bran (30/0), 30% Bran/15% Steep (30/15), and 45% Bran/15% Steep (45/15); with byproducts replacing DRC. Periods included a 16 d adaptation and 5 d collection. Chromic Oxide was used as a marker for digestibility, 15g/d. Ruminal fluid was collected prior to feeding and at 2, 4, 6, 8, 10 and 12 h post-feeding. Fecal samples were taken three times during the day. Byproduct diets had higher rumen pH (5.96) than CON (5.75) across all time points ($P < 0.01$). Total VFA concentration (mM) and acetate:propionate ratio (2.35) were not different among diets. DMI average was 11.4 kg/d and was not different among diets. Total tract DM digestibility was higher in CON vs byproduct diets (79% vs 73.0%, $P < 0.01$), as was OM digestibility (80.2% vs. 74.6%, $P < 0.01$). Nitrogen digestibility was not different across diet (67.7%). DM disappearance (%/h) of DRC was lower in CON diet (2.45) vs byproduct diets (2.93, $P < 0.01$). NDF of bran was 72.9%. NDF disappearance rates (%/h) were similar for 30/0 and 30/15 (1.71), and intermediate to CON (0.82) and 45/15 (2.01), ($P < 0.01$). NDF disappearance was not different among diets at 0, 12 and 24 h. However, at 48 and 96 h bran disappearance was lower for CON than byproduct diets ($P < 0.01$). Byproduct diets are shown to reduce acidosis and have lower DM digestibility and OM digestibility than CON diets, regardless of steep inclusion. Extent of corn bran digestion is greater in byproduct based finishing diets.

Key Words: Corn Bran, Digestibility, Beef Cattle

300 Effects of field peas in finishing feedlot performance. E. F. Fendrick*², I. R. Rush¹, D. B. Brink², G. E. Erickson², and D. B. Baltensperger¹, ¹*University of Nebraska Panhandle Research and Extension Center Scottsbluff*, ²*University of Nebraska*.

Field peas are produced mainly for the human market. However, to qualify for the human market peas have to meet a strict quality grade. The rejected field peas can be fed to livestock. The objective of this research is to determine the optimum level of field pea inclusion in a corn based diet, and to compare the feeding value of peas to corn. One hundred and twenty-nine steers were randomly assigned to four treatments with four pens per treatment. Field peas replaced corn in the diets at four different levels: 0%, 20%, 40%, 59% on a dry matter basis. Other ration ingredients included: corn, corn silage, and supplement. Due to the high level of protein in peas, two supplements were used with different levels of protein and Rumensin. Steer body weights were taken twice initially, once at 28 d intervals and just prior to shipping for harvest. Overall average DMI increased quadratically ($P < 0.02$) as level of peas in the diet increased. The feed conversion was not affected by level of peas ($P > 0.83$). The average daily gains for treatments were 1.87, 1.98, 1.95, and 1.78 kg/d for the 0%, 20%, 40%, and 59% field pea diets, respectively, and were not influenced ($P < 0.78$) by treatment. Based on this data, field peas have comparable feeding attributes to corn. Replacing up to 59% of diet DM with field peas produced similar average daily gain and F/G compared with a corn control diet.

Key Words: Field Peas, Corn, Protein

301 Stocking rate and corn gluten feed supplementation effects on the performance of bred heifers grazing stockpiled tall fescue-red clover forage during winter. J. T. Clark, J. R. Russell*, D. R. Strohbehn, J. D. Lawrence, and D. G. Morrical, *Iowa State University*.

Two 12.1-ha blocks containing 'Fawn' endophyte-free tall fescue and red clover were prepared to study the effects of stocking rates and corn gluten feed supplementation on growth and forage intake of pregnant beef heifers grazing stockpiled forages. In 2001 (yr 1) and 2002 (yr 2), forage was harvested as hay in two cuttings and stockpiled beginning

in early August. Each block was divided into four pastures containing 2.53 or 3.54 ha for stocking rates of 1.17 (high) or 0.84 (low) heifers/ha. On November 7 and October 23 of yr 1 and 2, 24 Angus and Angus x Simmental heifers in mid-gestation were allotted to the eight pastures. Eight similar heifers were placed in two dry lots and fed tall fescue-red clover hay. Corn gluten feed was supplemented to heifers in two of the pastures at each stocking rate and to heifers in the dry lots at levels to meet target weight gains for BW and conceptus gain while the remaining heifers were fed corn gluten feed only if weight gains did not meet those for conceptus gain. Average daily gains and body condition score increases were greater ($P < 0.05$) for heifers grazing stockpiled forage at either stocking rate than heifers fed hay in both years. Mean seasonal concentrations of IVDMD were greater ($P < 0.05$) and NDF, ADF, and ADIN were lower ($P < 0.05$) in the stockpiled forage than hay. In yr 1, heifers grazing stockpiled forage at the high and low stocking rates required 49 to 90% less corn gluten feed than heifers fed hay. In yr 2, heifers grazing stockpiled forage required no corn gluten feed while heifers fed hay required 0.84 kg/d. Mean forage and total DMI, as percentages of BW, of heifers grazing stockpiled forage did not differ between stocking and supplementation rates in November and March, but were lower ($P < 0.05$) than heifers fed hay in March. Mean production costs were 0.86, 0.87, 0.64, 0.65, and 1.17 \$/d for heifers grazing stockpiled forage at the low stocking rate without and with corn gluten feed, grazing stockpiled forage at the high stocking rate without or with corn gluten feed, and fed hay and corn gluten feed.

Key Words: Beef Cattle, Heifers, Grazing

302 Effect of processing flax on feedlot performance and carcass characteristics of beef heifers. T. D. Maddock*¹, V. L. Anderson², M. L. Bauer¹, K. Koch¹, R. J. Maddock*³, and G. P. Lardy¹, ¹*North Dakota State University*, ²*Carrington Research Extension Center*, ³*South Dakota State University*.

Beef heifers (n=128; 360 kg \pm 14 initial BW) were blocked by weight and assigned randomly to one of four treatment diets in a randomized complete block design (8 heifers/pen; 4 pens/treatment) to investigate if processing flax would have an effect on feedlot performance and carcass characteristics. Heifers were fed a growing diet for 56 d, after which they were offered a finishing diet until harvested. The growing diet included (DM basis) 31% corn, 30% corn silage, 18% barley malt pellets, 14% alfalfa, 4% linseed meal, and 3% supplement. The finishing ration consisted of (DM basis) 79% corn, 7% corn silage, 7% alfalfa, 4.75% linseed meal, and 2.25% supplement. Supplements were formulated to provide 0.5 mg MGA, 2000 IU vitamin E, and 232 mg monensin daily. Diets were 1) control (no flax), and either 2) whole flax, 3) rolled flax, or 4) ground flax added to the control diet at 8% of diet DM replacing all linseed meal and partially replacing corn. Blocks were harvested on d 96, d 97, and d 124 (two blocks). Treatment did not affect ($P > 0.15$) DMI, however gain efficiency (BW gain/DM intake) was greater ($P = 0.05$) for flax diets (0.134 \pm 0.005) compared to control (0.121 \pm 0.005). Average daily gain (kg/d) was increased ($P = 0.04$) with flax addition (1.52 \pm 0.05) vs. control (1.39 \pm 0.05) and tended ($P = 0.06$) to increase with processing (1.56 \pm 0.05) compared to whole flax (1.44 \pm 0.05). No treatment effects ($P > 0.10$) were noted for hot carcass weight, dressing percentage, 12th rib fat, or rib eye area. Flax addition increased ($P = 0.05$) internal (KPH) fat percent vs. the control diet (2.55 vs. 2.20 \pm 0.14). Yield grade also increased ($P = 0.05$) with flax addition (3.27 \pm 0.14) vs. those heifers fed the control diet (2.93 \pm 0.14). No differences ($P > 0.10$) were found for marbling scores (458.7 \pm 18.7; 400 = small 0). Flax addition increased gain efficiency and ADG, and processing flax tended to increase ADG, however yield grade increased with the inclusion of flax. Processing flax may optimize feedlot performance.

Key Words: Beef, Carcass, Flax

303 Direct-fed microbials as an intervention strategy to reduce the prevalence of *Escherichia coli* in feedlot cattle. R. E. Peterson*, T. J. Klopfenstein, D. R. Smith, G. E. Erickson, R. A. Moxley, and S. Hinkley, *University of Nebraska*.

A clinical trial was conducted during the summers of 2002 and 2003 to test the effectiveness of feeding a *Lactobacillus acidophilus* direct-fed microbial (DFM) product on the proportion of cattle shedding *Escherichia coli* O157:H7 in the feces. Steers (n = 448) were stratified by weight, and assigned randomly to pen (n = 48; 8 hd/pen in 40 pens; 16

hd/pen in 8 pens) and then assigned randomly to DFM or no DFM. The DFM products were mixed with water and applied to the feed in a mixing box of a separate feed truck (to eliminate the chance of cross contamination) at the rate of 1 x 10⁹ colony forming units (CFU's)/steer/day. Fecal samples were collected (n = 2,944) from each animal every three weeks by rectal palpation and O157 was isolated using selective enrichment, immunomagnetic separation, and PCR confirmation. The outcome variable was the pen prevalence of O157, and defined as the percentage of cattle within a pen from which the organism was isolated from feces. Performance and O157 outcomes were analyzed using the GENMOD procedure of SAS using pen as the experimental unit and accounting for repeated measures, year, and block. Prevalence varied significantly between 2002 and 2003. In 2002 the probability for a DFM-treated steer to shed O157 over the test periods was 13% compared to 21% among untreated cattle. In 2003 the average probability of shedding was 21% among DFM-treated steers compared to 28% for controls. Over the two years DFM treated cattle were 35% less likely to shed O157 than cattle in untreated pens (P = 0.002). Feeding the DFM product did not affect (P > 0.10) overall ADG, DMI, or ADG:DMI. Because there was a reduction in O157 shedding we conclude that DFM supplementation is currently a reliable intervention strategy when trying to reduce the proportion of feedlot cattle shedding *E. coli* O157:H7 in the feces.

Key Words: Cattle, Direct-Fed Microbial, *Escherichia coli*

304 Influence of castration method on receiving calf performance and immune characteristics. T. J. Wistuba*¹, E. B. Kegley², M. E. Davis², and S. L. Krumpelman², ¹Morehead State University, ²University of Arkansas.

Method of castration may be one of a number of factors that influence the performance and health of receiving cattle. Therefore, an experiment was conducted to determine the effects of castration method on performance and immune characteristics of beef calves. Initially, 91 crossbred male calves (56 bulls, 35 steers; 246 ± 19 kg) were purchased at area auctions and shipped to the University of Arkansas Stocker Unit in Savoy, AR. Upon arrival calves were weighed, tagged and allowed access to long stem hay and water for 24 h. The 28-d study utilized 45 crossbred males (30 bulls and 15 steers; 245 ± 11.8 kg initial BW). Three treatments consisted of: 1) calves that arrived at the unit as steers; 2) calves that were castrated utilizing a bander, and 3) calves that were surgically castrated. Steers were housed in 0.45 ha grass lots and were offered ad libitum hay and 1.75 kg of a grain supplement/d. Steers were weighed and bled by jugular venipuncture on d 0, 3, 6, 14, and 28 and were weighed on consecutive days at d 0 and 28 to start and finish the trial. On d 3 calves that had been banded lost more (P = 0.02) weight than calves that were surgically castrated or arrived as steers. However, on d 6, 14, and 28, calves that had arrived as steers had a higher ADG than those calves that were castrated after arrival. There were no differences in total or individual concentrations of white blood cells between calves in different treatment groups on d 0 (P < 0.10). However, surgically castrated calves had increased concentrations of total white blood cells when compared to those calves that arrived as steers on d 3 (P = 0.05). Calves that were surgically castrated or banded had a lower (P < 0.05) concentration of total neutrophils and monocytes on d 3 than calves that arrived as steers. Concentrations of lymphocytes, eosinophils, and basophils did not differ due to treatment. This study suggests that method of castration does not play an important role in receiving cattle performance. However, if calves are castrated prior to this time, performance can be enhanced.

Key Words: Health, Calves, Management

305 Effects of esterification, degree of saturation, and amount of fatty acids infused into the rumen or abomasum on nutrient and fatty acid digestibilities in lactating dairy cows. N. B. Litherland*, A. D. Beaulieu, and J. K. Drackley, University of Illinois.

Six multiparous Holstein cows with ruminal cannulas were used in a 6 × 6 Latin square design with 21-d periods. During d 1-14, 250 g/d of fatty acids (FA) and during d 15-21, 500 g/d of FA were infused continuously into the rumen or abomasum via the rumen cannula. Treatments were infusions of 1) Control; 200 g/d of meat solubles + 12 g/d of Tween 80 in 10 L of water; 2) control plus mostly saturated FA into the abomasum (SFAA); 3) control plus mostly saturated FA into the rumen (SFAR);

4) control plus soy free FA into the abomasum (UFAA); 5) control plus soy triglycerides into the abomasum (TAGA); and 6) control plus soy triglycerides into the rumen (TAGR). Cows were fed a TMR (17.5% CP, 21.4% ADF). Production data were presented previously (J. Dairy Sci. 85 (Suppl 1): 142). Intakes of DM, OM, CP, ADF, NDF, and gross energy were decreased more by increasing UFAA than by increasing TAGA (P < 0.05). Apparent total tract digestibilities of DM, OM, CP, ADF, NDF, and gross energy were decreased by UFAA compared with TAGA (P < 0.05); digestibilities of DM, CP, and energy were decreased more by increasing the amount of UFAA infused (level, P < 0.05). During infusion of 250 g/d of FA, apparent total tract digestibilities of total FA were 76.7, 69.2, 80.1, 71.4, 72.9, and 72.0% for control, SFAA, SFAR, UFAA, TAGA, and TAGR, respectively. When 500 g/d of FA were infused, FA digestibilities were 74.6, 67.7, 75.5, 45.6, 76.1, and 70.6, respectively. Total FA digestibilities were lower when 500 g/d of FA were infused than when 250 g/d were infused (P < 0.05). Apparent digestibility of total FA was decreased more by increasing UFAA than TAGA (esterification and esterification × level, P < 0.05) and was greater for SFAR than for SFAA (site of SFA infusion, P < 0.05). Postprandial infusion of unsaturated free FA reduced intake and digestibility of nutrients and FA; saturated FA did not disrupt nutrient digestion. Saturated FA were digested equally as well as, or greater than, unsaturated FA.

Key Words: Fatty Acids, Digestibility, Dietary Fat

306 Influence of supplemental fat on performance, lactation and reproduction of beef cows. D. W. Shike*, D. B. Faulkner, D. J. Kesler, and F. A. Ireland, University of Illinois.

Five hundred and sixty Angus x Simmental cows were utilized to evaluate the effects of supplemental fat on performance, lactation and reproduction. Cows were blocked by age and allotted prior to calving to one of four dietary supplements: whole raw soybeans (WRS), flaxseed, tallow and corn / soybean meal (control). Flaxseed and tallow were added to a corn / soybean meal base and were formulated to have the same level of fat as WRS. The flaxseed, tallow and control supplements were isonitrogenous. Cows were fed 1.81 kg DM / day of supplement for 105 d while grazing endophyte-infected tall fescue, red and white clover pastures. Supplemental fat ended at breeding. Only data from cows calving in the first 60 days of the calving season were used for analysis. Single degree of freedom orthogonal contrasts were: WRS vs. flaxseed, WRS vs. tallow, and fat supplemented vs. control. There were no differences (P > 0.05) in cow ADG, calf ADG, or milk production in any of the contrasts. Soybean supplemented cows had higher (P < 0.05) total milk fat and milk urea nitrogen (MUN) than flaxseed cows. Soybeans did not influence (P > 0.05) total milk protein compared to flaxseed or tallow. However, both total milk fat and MUN were higher (P < 0.05) in WRS cows than tallow cows. Fat supplementation increased (P < 0.05) total milk fat and MUN compared to controls. There were no differences (P > 0.05) in AI conception rates in any of the contrasts. However, conception rates to bulls were lower (P < 0.05) in WRS cows (65%) compared to flaxseed cows (79%) or tallow cows (76%). Thus, WRS cows had lower (P < 0.05) overall pregnancy rates than flaxseed cows (83% vs. 91%) and tended (P < 0.10) to have lower pregnancy rates than tallow cows (83% vs. 89%). There was no difference (P > 0.05) in conception to bulls or overall pregnancy rate between fat supplemented cows and controls. Although there were no differences in AI conception rates, WRS supplementation decreased the number of pregnancies from clean-up bulls. This may be due to the phytoestrogen levels in WRS.

Key Words: Dietary Fat, Soybeans, Cows

307 Milk and calf adipose tissue fatty acid changes in response to maternal supplementation with high-linoleate or high-oleate safflower seeds. S. L. Lake*, B. W. Hess, E. J. Scholljegerdes, R. L. Atkinson, and D. C. Rule, University of Wyoming, Animal Science Department.

Three-year-old Angus × Gelbvieh (n = 36) beef cow-calf pairs were used to determine the affect of dietary supplemental fat on milk and calf adipose tissue fatty acid profile. Beginning 3 d postpartum, cows were randomly assigned to be individually fed native grass hay at 2.13% of BW plus a low-fat control supplement (0.57% of BW), hay at 2.32% of BW plus a high-linoleate cracked safflower seed supplement (0.40 % of BW), or hay at 2.31% of BW plus a high-oleate safflower seed supplement (0.40% of BW) until d 60 postpartum. Cracked safflower seed

supplements were formulated to provide 5% DMI as fat. Rations were formulated to be isonitrogenous and isocaloric. Milk and calf tail head adipose tissue samples were collected for fatty acid analysis on d 60 of lactation. Milk output (g fatty acid produced per 24 h) of 10:0, 12:0, 14:0, and 16:0 was greatest ($P < 0.001$) for Control. Milk output of 18:0 and 18:1*cis*-9 was greater ($P < 0.001$) in both Linoleate and Oleate than Control cows. Linoleate cows had the greatest ($P < 0.001$) milk output of 18:1*trans*-10 and 11, 18:2, and CLA (18:2*cis*-9, *trans*-11), whereas Oleate had the greatest ($P \leq 0.003$) output of 18:1*trans*-9. Adipose tissue of calves nursing Control cows had the greatest ($P \leq 0.03$) content (mg fatty acid/g tissue) of 12:0, 14:0, and 16:0. Linoleate and Oleate calves had greater ($P \leq 0.003$) 18:1*cis*-9 in adipose tissue than Control calves. Calves nursing Linoleate dams had the greatest ($P \leq 0.02$) 18:0, 18:1*trans*-11, 18:2, and CLA, while calves from Oleate dams had the greatest ($P \leq 0.005$) concentrations of 18:1*trans*-9 and 10 in adipose tissue. Supplementing high-linoleate or high-oleate safflower seeds to lactating beef cows will alter milk fatty acid output, as well as adipose tissue fatty acid concentration of the nursing calf. Thus, the nursing calf's deposition of physiologically important fatty acids can be altered through nutritional manipulation of the dam.

Key Words: Beef Cows, Fat Supplementation, Fatty Acids

308 Comparison of beef tallow versus poultry fat in the finishing diets of steers on performance, carcass traits, and beef palatability of finishing steers. S. Hutchison^{*1}, E. B. Kegley¹, J. K. Apple¹, T. J. Wistuba², and M. E. Dikeman³, ¹University of Arkansas, ²Morehead State University, ³Kansas State University.

Poultry fat has become a more economical source of energy than by-products currently used. Therefore, a 112-d finishing study was conducted to determine the effects of type of fat (poultry or tallow) in finishing diets for cattle on growth performance, carcass characteristics, and meat palatability. Sixty Angus crossbred steers (410.8 kg initial BW) were stratified by source, blocked by weight, and assigned within block to 15 pens (4 steers/pen). Pens were then assigned randomly within blocks to one of three dietary treatments consisting of: 1) a corn-soybean meal control diet devoid of supplemental fat (Ctrl); 2) the control diet formulated with 4% tallow (TAL); or 3) the control diet formulated with 4% poultry fat (PF). ADG for the 112-d study was not ($P > 0.05$) different among dietary treatments; however, steers fed PF had approximately a 10% numeric improvement ($P = 0.17$) in ADG over Ctrl and TAL fed steers. Steers fed TAL consumed less ($P < 0.05$) feed daily than steers fed the Ctrl-diet. Steers fed the diets containing PF had improved ($P < 0.05$) G:F when compared to the steers fed the Ctrl, with steers fed TAL being intermediate. Dietary fat level or source did not affect ($P > 0.10$) carcass weight, longissimus muscle (LM) area, fat thickness, internal fat percentage, yield grade, marbling score, or quality grade. Dietary treatments did not ($P > 0.05$) affect cooking loss percentages; however, LM steaks from steers fed the fat diets had higher ($P > 0.05$) shear force values than steaks from Ctrl-fed steers. Conversely, trained sensory panelists failed to detect ($P > 0.05$) a difference among dietary treatments for tenderness, juiciness, connective tissue content, flavor intensity, or off-flavor intensity. Feeding PF improved G:F; thus, it may serve as an alternative economical energy source in finishing cattle diets without compromising performance, carcass characteristics, or cooked beef palatability.

Key Words: Poultry Fat, Tallow, Fat Supplementation

309 Relationship of mitochondrial function to feed efficiency in crossbred Angus steers. J. W. Golden^{*}, M. S. Kerley, J. H. Porter, and C. J. Fu, *University of Missouri*.

A study was conducted to determine the relationship between feed efficiency and mitochondrial function. The hypothesis was that steers exhibiting poor feed efficiency had a lower mitochondrial respiratory efficiency. Crossbred Angus steers ($n = 80$), were fed ad libitum and individual feed intakes were recorded by the GrowSafe[®] computer intake system. Intakes were used to calculate residual feed intake (RFI), a measure of efficiency. After RFI values were calculated over three consecutive months, mitochondria were isolated from the Longissimus lumborum muscle from steers with low RFI (-1.564; $n = 6$) and high RFI (1.657; $n = 6$). Respiratory chain coupling, assessed by the respiratory control ratio (RCR), was numerically greater in the high efficiency

group but did not statistically differ ($p > 0.05$) between groups provided either NADH-linked or FADH-linked energy substrates. The ratio of the maximal rate of ADP-induced O₂ consumption to the basal rate in the absence of ADP, assessed by the acceptor control ratio (ACR), was numerically greater in the high efficiency group but did not statistically differ ($p > 0.05$) between groups provided either NADH-linked or FADH-linked energy substrates. There were no differences ($p > 0.05$) in the adenosine diphosphate to oxygen (ADP: O) ratio (an index of oxidative phosphorylation) when mitochondria were provided either energy substrate. Even though statistical differences were not noted due to large random error, the numerical analysis of data from this research suggested that a relationship between mitochondrial function and feed efficiency existed, as has been demonstrated in other species.

Key Words: Residual Feed Intake, Mitochondrial Function

310 Evaluation of Revalor-IS and Synovex-S as initial implants for finishing steers. J. D. Folmer^{*1}, T. B. Farran¹, G. E. Erickson¹, T. J. Klopfenstein¹, C. D. Reinhardt², B. D. Dicke³, and J. S. Drouillard⁴, ¹University of Nebraska, ²Intervet Inc., ³Cattlemen's Consulting, ⁴Kansas State University.

A commercial feedlot experiment utilizing 1038 steers (initial BW = 263 kg) was conducted to evaluate a new low-dose initial implant compared to a more traditional initial implant for feedlot steers. Steers were implanted with either Revalor-IS[®] (IS) (16 mg estradiol, 80 mg trenbolone acetate) or Synovex-S[®] (S) (20 mg estradiol benzoate, 200 mg progesterone) at initial processing. Each group of incoming steers constituted a treatment replication, with a total of six replications per treatment (12 pens total). Steers were assigned to treatment by every other animal during initial processing. After processing, pens were immediately group weighed to establish initial pen weight. All replicates were fed a common finishing diet, and received a Revalor-S (24 mg estradiol 17 β , 120mg trenbolone acetate) as the terminal implant 78 d (range 71 to 84 d) prior to slaughter. Steers were fed an average of 180 d (range 170 to 191 d). Steer performance and carcass characteristics were assessed to evaluate the effects of initial implant with pen used as the experimental unit. DMI (8.9 vs 9.0 kg), ADG (1.67 vs 1.65 kg), feed efficiency (0.188 vs 0.183 kg gain / kg feed), and final live weight (558 vs 556 kg) were similar between IS and S treatments, respectively. Implanting steers initially with IS tended ($P = .07$) to increase hot carcass weight (355 vs 353 kg) and carcass adjusted final weight (563 vs 559 kg) compared to steers implanted initially with S. Implanting steers initially with IS had no effect on dressing percent (63.6 vs 63.4%), empty body fat percentage (28.8 vs 28.8%), or percent Choice carcasses (55.6 vs 58.2%) versus an initial implant of S. In addition, there were no differences in 12th rib fat thickness, marbling score, longissimus muscle area, or calculated yield grade. Selling IS implanted steers on a carcass merit basis returned \$4.95/head more than S implanted steers, but this difference was not significant ($P = 0.57$). Results indicate similar performance between IS and S. In addition, there may be improvement in hot carcass weight and carcass adjusted final weight, with no negative impact on carcass characteristics.

Key Words: Implants, Steers, Carcass

311 Influence of implant regimen on performance and carcass characteristics in feedlot steers. H. L. Haugen^{*1}, G. E. Erickson¹, C. G. Campbell², and C. N. Macken¹, ¹University of Nebraska, ²Fort Dodge Animal Health.

A feedlot trial was conducted using 480 crossbred steers (281 kg) to evaluate the influence of implant strategies during the finishing phase on performance and carcass characteristics and to determine the impact of implant strategies on carcass quality with additional days on feed. Steers were stratified by weight and assigned randomly to one of six treatments: Synovex Choice/Synovex Choice (CH/CH), Revalor-IS/Revalor-IS (IS/IS), Synovex Choice/Revalor-IS (CH/IS), Revalor-IS/Revalor-S (IS/S), Ralgro/Revalor-S (RAL/S), and Ralgro/Synovex Plus (RAL/PL). Initial implants for all treatments were administered on d 0. Steers initially implanted with RAL were reimplanted on d 63, and steers initially implanted with CH or IS were reimplanted on d 84. Steers were assigned randomly to early and late (155 and 174 d on feed, respectively) slaughter groups within each pen (4 pens/trt), so that 10 steers/pen were marketed on d 155 followed by the remaining 10 steers/pen on d 174 (20 steers/pen). Steers were fed a common finishing

diet of 43.5% high moisture corn, 40% wet corn gluten feed, 10% corn silage, 3.5% tallow, and 3% supplement. Contrasts were constructed to compare CH vs IS, CH/CH vs IS/IS, and initial CH vs initial IS. Implant strategies including CH increased ADG and rib eye area compared to strategies including IS ($P \leq 0.06$). Steers implanted with CH/CH had improved performance compared to steers implanted with IS/IS; however, performance was not different for CH vs IS as initial implants (S terminal implant). Marbling was similar across implant strategies indicating the observed increase in performance with CH was achieved without negatively influencing carcass quality. Live ADG and feed conversion were not different ($P > 0.05$) for early and late slaughter groups suggesting performance does not decrease late in the finishing period. In fact, dressing percent increased ($P < 0.01$) from 64.0% in the early slaughter group to 64.9% in the late group. Empty body fat and 12th rib fat thickness increased ($P < 0.05$) in the late slaughter group compared to the early slaughter group while marbling was not different ($P > 0.05$).

Key Words: Implants, Performance, Carcass Traits

312 Comparison of bovine transfer factor and tilmicosin phosphate: effects on health and performance of receiving heifers. S. P. Montgomery*, J. S. Drouillard, M. A. Greenquist, J. J. Sindt, W. F. Miller, J. N. Pike, E. J. Good, E. R. Loe, M. J. Sulpizio, and T. J. Kessen, *Kansas State University*.

Transfer factors are antigen specific products of T lymphocytes that are capable of transferring delayed-type hypersensitivity and cell-mediated immunity. Two experiments were conducted to evaluate bovine transfer factor (TF) for use in receiving cattle. In Exp. 1, crossbred beef heifers ($n = 665$, initial BW = 225 kg) were used in a completely randomized design to determine the effects of TF on the health and performance of beef cattle during a 36-d receiving period. On d 1, heifers were processed and processing included injection with 10 mg of tilmicosin phosphate/kg of BW s.c. or oral administration of 700 mg of TF isolated from bovine colostrum. Heifers given TF during initial processing received an additional 700 mg of TF per d in the diet between d 2 and 5. Heifers were monitored for clinical signs of bovine respiratory disease (BRD) and heifers exhibiting signs of BRD received antibiotic therapy. The percentage of heifers treated once, twice, or three times for BRD was greater ($P < 0.01$) for heifers given TF compared to heifers given tilmicosin phosphate (72.5 vs 47.1; 31.5 vs 14.7; and 18.0 vs 4.2, respectively). There were no differences between TF and tilmicosin phosphate with respect to DMI ($P > 0.73$), ADG ($P > 0.92$), or gain efficiency ($P > 0.95$) of heifers. In Exp. 2, rumen fluid was incubated either alone (control), with casein, or with TF. Samples were obtained every 30 min during a 1.5-h in vitro incubation period and analyzed for NH_3 and total AA concentration. Rate of increase of in vitro NH_3 concentration was greatest ($P < 0.02$) for TF compared to casein or control, while the rate of increase of in vitro total AA concentration was greatest ($P < 0.02$) for casein and intermediate ($P < 0.02$) for TF relative to control. Results indicate that TF is not as effective as tilmicosin phosphate in decreasing BRD in receiving cattle, and that TF protein undergoes extensive ruminal degradation.

Key Words: Receiving Cattle, Bovine Transfer Factor, Tilmicosin Phosphate

313 Effects of selenium source on characteristics of selenium digestibility in finishing beef steers. S. A. Soto-Navarro*, G. J. Williams¹, J. B. Taylor³, J. W. Finley², and J. S. Caton¹, ¹*Department of Animal and Range Sciences, North Dakota State University*, ²*USDA-ARS*, ³*USDA-ARS*.

Four ruminally and duodenally cannulated steers (604 ± 9.26 kg initial BW) were used in a 4×4 Latin square to evaluate effects of Se source on characteristics of Se digestibility. Steers were offered feed ad libitum at 0700 and 1900 daily and were allowed free access to water. The basal diet contained (DM basis) 25% grass hay, 25% wheat, 39% corn, 6% desugared molasses, and 5% wheat middling-based supplement. Treatments were: 1) Se adequate (CON; 0.38 ppm Se), or Se provided as high Se wheat (WHT; 2.86 ppm Se), high Se hay (HAY; 2.80 ppm Se) or sodium selenate (SEO; 2.84 ppm Se). Diets were formulated to supply 65 $\mu\text{g}/\text{kg}$ BW (WHT, HAY, and SEO), and 9.5 $\mu\text{g}/\text{kg}$ BW (CON) of Se, and were similar in N and energy content (14.0% CP, 2.12 Mcal NEm/kg DM, and 1.26 Mcal NEg/kg DM). Wheat and hay in CON were

replaced with high-Se wheat and hay in WHT and HAY (10.26 and 10.17 ppm Se, respectively). Experimental periods consisted of 9-d diet adjustment followed by 5-d collection. Dry matter intake, OM intake, and total tract OM digestibility were not affected ($P > 0.10$) by treatment. Analyzed dietary Se was 0.42, 3.0, 5.47, and 3.15 ppm for CON, WHT, HAY, and SEO, respectively. Selenium flow to the duodenum ranked as following: CON < WHT = SEO < HAY ($P < 0.01$; 3.9, 23.2, 28.2, and 39.5 ± 3.27 mg/d, respectively). However when expressed as % of Se intake, Se flow to duodenum was not affected ($P > 0.10$) by treatment. Microbial Se reaching the duodenum was lower ($P < 0.01$) for CON and SEO compared with WHT and HAY (2.4, 6.1, 10.9, and 15.5 ± 1.81 mg/d, respectively). When expressing microbial Se flow as % of Se intake, CON > WHT = HAY = SEO, and WHT > SEO ($P < 0.01$; 59.9, 36.7, 27.6, and $21.2 \pm 5.6\%$, for CON, WHT, HAY, and SEO, respectively). Total tract Se digestibility of CON was lower than WHT and HAY ($P = 0.07$), and SEO was similar to CON, WHT, and HAY. No effects ($P > 0.10$) on apparent ruminal, true ruminal or postruminal Se disappearance were noted. When providing Se at supranutritional levels, organic sources of Se increased incorporation of Se into ruminal bacteria and increased total tract Se disappearance.

Key Words: Selenium, Digestibility, Steers

314 Public concern for the impact of livestock and poultry production systems on the environment. H. F. Tyrrell*, *CSREES - USDA*.

The structure of the livestock and poultry industry has changed dramatically during the last 50 years. That change has included a reduction in the number of farms producing livestock, a dramatic increase in the number of animal units per farm, and a concentration of production units in a relatively small geographic area. Livestock and poultry production has become much more specialized with the majority of feed nutrients being imported to the production unit, often great distances from where crops used for the production of feed are grown. Historically, most of the nutrients contained in manure have been returned to the land as fertilizer for the next crop. With the separation of livestock and poultry production from crop production, manure has become a liability rather than an asset for producers. Because of the transportation cost, manure has been applied to too small a land base for effective uptake by crops, or simply allowed to decompose with volatile compounds lost to the atmosphere and non-volatile nutrients accumulating in a 'toxic dump'. Unfortunately, this type of manure management leads to contamination of both public water and air. This situation becomes particularly difficult for livestock and poultry producers located close to an urban population center. Concentrated animal production operations can be regulated under provisions of both clean water and clean air legislation. It is in the best interest of parties on both sides of the issue to work cooperatively to resolve environmental issues related to food production. Nutrients in manure have value, and the livestock and poultry industries should focus on capturing that value.

Key Words: Manure, Nutrients, Environment

315 Regulations and ruminations: Federal regulatory considerations for nitrogen and phosphorus management for beef and dairy operations. J. S. Jonker*, *National Research Council*.

The livestock industry has undergone dramatic changes in the past 20 years. The trend toward fewer but larger operations, coupled with greater emphasis on more intensive production methods and specialization, has concentrated more animal manure within some geographic areas. At the same time, suburban encroachment has occurred in many traditional livestock production areas. This increase in geographic concentration coupled with increased suburbanization has led to an increasing concern over environmental impacts of animal agriculture. A myriad of federal regulations provide oversight to reduce the environmental footprint of animal agriculture. The most recent federal regulatory change occurred on December 15, 2002 when the U.S. Environmental Protection Agency finalized the Clean Water Act National Pollutant Discharge Elimination System and Effluent Limitation Guidelines for concentrated animal feeding operations. These revised regulations set new guidelines for control technologies to reduce nitrogen and phosphorus contamination from livestock farms to surface water. In addition, the regulations establish permitting requirements for dairy farms with 200 milk cows

and feedlots with 300 beef cattle. The U.S. Environmental Protection Agency is now considering permitting regulations for concentrated animal feeding operations under the Clean Air Act. This potential regulatory action is being considered due to a number of gaseous emissions to the atmosphere from livestock farms including the loss nitrogen. Several other federal regulations, including the Coastal Zone Management Act; Emergency Planning and Right to Know Act; and the Comprehensive Environmental Response, Compensation, and Liability Act have implications for control technologies or reporting requirements for some livestock farms. In response to current and potential federal regulations, a whole-farm nutrient management or systems approach to managing nutrients is an appropriate approach to reduce the environmental footprint of livestock production. A whole farm approach will allow for analysis of critical control points to reduce nitrogen and phosphorus emissions to water and air.

Key Words: Nutrient Management, Regulation

316 Nitrogen and phosphorus management in feedlots. G. E. Erickson*, T. J. Klopfenstein, J. R. Adams, T. B. Farran, C. B. Wilson, K. M. Sayer, and B. G. Geisert, *University of Nebraska*.

Numerous dietary and management options are available to reduce the environmental challenges of manure nutrients from beef feedlots, including more accurate feeding to meet protein and P requirements, distributing P, and pen management techniques. Nutrient retention by cattle is relatively low (<25%) based on NRC equations. Therefore most of the N and P fed to cattle are excreted in feces and urine. Two separate challenges exist with volatilization the primary concern for N and distribution for P. Current NRC recommendations on P requirements is incorrect. Based on three P requirement studies, the dietary P requirement for finishing calves and yearlings is <0.14% of diet DM. This equates to 60 to 75% of current recommendations. Corn based diets contain a minimum of 0.25% P. Therefore, supplementation of mineral P in feedlot diets is unnecessary because feedlot diets contain too much P. Use of byproduct feeds due to economics will elevate manure P. Manure P needs to be distributed more appropriately in the future. Nitrogen losses via volatilization from accumulated manure are large, but variable across season. Using mass-balance techniques across 12 experiments, N losses averaged 90 g/d or 48% of N excreted in winter-spring feeding periods and 139 g/d or 68% of N excreted during the summer months with

conventional diets and management. Nitrogen losses may be decreased by 25 to 35% by decreasing dietary protein while maintaining performance. Adopting the metabolizable protein system and phase-feeding, or changing the diet over time to not exceed the changing requirement, minimizes N volatilization. Cleaning pens monthly will decrease N losses by 14 percentage units. Increasing OM on the pen surface by increasing roughage or feeding fibrous byproducts will also decrease N losses, but only during the winter. Other techniques may be required in the future to further minimize N losses. Both N and P will need to be managed in the future to ensure that beef feedlots are economically and environmentally sustainable.

Key Words: Nitrogen, Phosphorus, Beef Cattle

317 Monitoring N and P management on dairy farms. J. D. Ferguson* and Z. Dou, *University of Pennsylvania*.

Nitrogen and phosphorus may be lost to the environment from several main collection points on a dairy facility. N may be lost from the housing structure, manure collection and storage structure, and field application. Losses of N may occur through volatilization, run-off and leaching. P losses are a risk with field application of manure and erosion of surface material from fields, but losses may also be incurred due to surface run-off from barn yards and points where cows congregate. Controlling dietary inputs is a major tool which can be used to reduce environmental losses in addition to manure containment. Volatile losses of ammonia from dairy facilities can be major, representing over 25% of dietary inputs. Ammonia is rapidly produced from urinary urea when urine and feces mix. Decomposition of urea to ammonia is influenced by pH and temperature. Urinary creatinine decomposes more slowly. Ammonia produced may volatilize from barn floors and gutters depending on pH, depth of manure, and air movement through the facility. Balancing dietary supply of rumen degradable and undegradable protein with rumen available carbohydrate can help reduce urinary urea concentrations and ammonia losses. Monitoring target values of milk urea nitrogen provide a tool to minimize urea nitrogen losses. Dietary phosphorus should be kept at below .4% of DM to minimize fecal concentrations.

Key Words: Nitrogen, Phosphorus, Dairy

Teaching

318 Evaluating acceptance of course modules in a virtual course: Introduction to animal sciences. M. Latour* and A. Cox, *Purdue University*.

Introduction to Virtual Animal Sciences 101 is a vibrant and exciting course, which is currently offered completely online to n=40 students. The course is designed to teach the fundamentals of animal agriculture through a series of course modules (n=20). Modules are arranged with specified goals, where students do a variety of activities (utilize interactive webpages, QuickTime video clips, digital images, etc.) along with completion of module questions. Of the twenty modules, two modules are completely unique; that is, students must take information learned in the previous modules and then complete two written assignments. The remaining eighteen modules are digital in nature (web-based only and utilize interactive components mentioned above) and provide the foundation or framework needed to complete the two written modules, i.e., the basis of nutrition, genetics, physiology, etc. The written modules require a personal visit and extensive write-up. The objectives of this study were to compare all modules, i.e., ranking of preference and in a following survey, students were questioned why they ranked specific modules over one another. Regardless of written module, students preferred the written assignments significantly higher when compared to digital modules (favored 8-times), with no difference between written modules. No significant differences were observed in student preferences between digital modules. Students perceived the work load to be significantly greater (2.75-times) for written assignments when compared to digital modules. When students were surveyed on why these two modules stand out, they consistently replied the personal interaction and visit with a true expert, were the major factors in choosing the preference for a module. In summary, this study demonstrates that students showed no preference for digital learning modules, but clearly enjoyed

the writing assignment, which included one-on-one visits with experts. In the Midwest, these papers included many positive experiences for students with swine-nutritionist and -producers.

Key Words: Distance, Learning, Teaching

319 Animal welfare education modules: Enhancing the quality of education for students of food animal agriculture and health. J.M. Osborne¹, K.E. Fike*¹, K.A. Grove¹, G.D. Fike*¹, K.H. Hoblet¹, J.E. Kinder¹, and P.H. Hemsworth², ¹*The Ohio State University*, ²*Animal Welfare Centre, Australia*.

Departments of Animal Sciences and Colleges of Veterinary Medicine train decision makers regarding food animal production, health, and harvesting practices. Teaching modules concerning animal welfare that are easily incorporated into existing courses facilitates the inclusion of animal welfare curriculum in the education of students. The goal of this project is to develop education modules covering issues such as: animal ethics, scientific assessment of animal welfare, biological adaptations and stress. Modules include instructor's notes, PowerPoint presentations and student handouts, available as a booklet and interactive CD. Module content is evaluated and updated by scientists with expertise in animal science and welfare, behavior, and sociology. These modules: 1) educate students on animal welfare issues, 2) provide science-based information on animal welfare practices, 3) prepare students to deal with these issues using knowledge-based judgments, and 4) encourage students to be proactive in dealing with public sentiment. Module 1, "Animal Ethics and Animal Welfare", an introduction to the topic of animal welfare covering the breadth of the modules, is being reviewed by faculty and student focus groups. Instructors find the module delivery

system to be flexible, facilitating integration into existing courses. Student feedback regarding module content and mode of delivery as well as surveys before and after presentation of the module regarding attitudes about animal welfare are critical in determining the effectiveness of the materials. As a result of this project, students will be better prepared to provide sound, science-based advice on animal welfare practices to industry, interest groups and the public, and be proactive in dealing

with public sentiment. Future goals include placing the modules on the World Wide Web for access by other universities, and adaptation for outreach to youth, producers and consumers. (Supported by USDA-HEC 2001-38411-10740.)

Key Words: Animal Welfare, Curriculum

Undergraduate Student Competition Papers

320 Physiological and colonic microbial responses in the horse to feeding soyhulls. K. J. Willer, J. A. Carroll, and M. S. Kerley, *University of Missouri*.

Soyhulls have a nutritional profile that makes them an excellent energy feedstuff for the horse. They have been used in horse rations, and have been shown to promote beneficial bacteria growth in the colon. The hypothesis of this research was that the horse would extensively digest soyhulls, that indigenous bacterial populations in the colon would be increased, and plasma insulin concentration would be reduced. To test this hypothesis, four two year-old horses were fed experimental diets in a 4x4 Latin Square design. In each period diets were fed three weeks for acclimation followed by one week for blood and fecal sampling. Blood samples were collected at 1700 hrs on days 23-27 of each period. Diets consisted of (1) alfalfa hay, (2) 75% alfalfa hay and 25% soybean hulls, (3) 50% alfalfa hay and 50% soybean hulls, and (4) timothy hay. A commercially available supplement designed to make diets nutritionally complete or in excess of NRC recommendations was fed with all treatment diets. These diets resulted in variations of fiber level and form. Horses used in this experiment were stabled so feed intake could be measured and feces could be collected. Horses were managed according to approved animal handling procedures. Measurements made included fiber and nutrient digestibility, bacterial enumeration, plasma insulin, blood glucose and blood urea nitrogen. Grain intake was 5 and 6 lbs for periods 1-3 and 4, respectively. Roughage intake was 10 and 12 lbs for periods 1-3 and 4, respectively. Intake was increased due to horses being slightly thin. Supplements were individually offered. Horses were weighed on day 25 of each period and body condition scored on day 28 of each period. Lactobacillus populations did not differ among diets. Horses fed diet 2 (75% alfalfa 25% soyhulls) had greater population counts of Bifidobacteria and E. Coli. Horses fed timothy hay had the lowest ($p < 0.05$) plasma insulin and blood urea nitrogen (bun) level. Feeding soyhulls also reduced bun level. Horses were capable of extensively digesting soyhull fiber.

Key Words: Microbial Response, Physiological Response, Soyhulls

321 Effects of temperature and feeding regime on early weaned pig performance. Z. C. Hall* and B. S. Zimprich, *North Dakota State University*.

Objectives of this study were to investigate effects of lower temperatures and different feeding regimes on performance of early weaned pigs. Four groups of 24 randomly selected crossbred pigs were weaned 13-14 d post farrowing. Pigs were housed in individual nursery pens for six weeks. Each group consisted of 12 pigs weighing 3.18-3.64 kg and 12 pigs weighing 5-5.45 kg. Diets consisted of four feeding regimes: 1) prestarter (19.7% CP, 1.6 Lys, 3560 kcal/kg ME); 2) Starter 1 (21.6% CP, 1.5% Lys, 3204 kcal/kg ME); 3) Starter 2 (19.5% CP, 1.1% Lys, 3081 kcal/kg ME). Treatments included six small (S5P) and six large (L5P) pigs starting on 2.27 kg prestarter and six small (S8P) and six large (L8P) pigs starting on 3.64 kg prestarter. After initial feeding of prestarter, S5P- and L5P-pigs were stepped up to a Starter 1 diet until they reached 11.36 kg (± 0.45 kg), and S8P- and L8P-pigs were fed to 13.64 kg (± 0.45 kg). After pigs reached their respective weights, they were transitioned to a Starter 2 diet for the remainder of the trial. Effect of temperature on growth performance was also evaluated. Groups 1 and 3 resided in the nursery at 32.2°C with a 1.1°C drop every week. Groups 2 and 4 entered the nursery at 26.7°C and temperature was reduced at 0.6°C each week. At the onset of the trial L5P- and L8P-pigs were heavier than S5P- and S8P-pigs (5.21, 5.19 vs. 3.76 and 3.68 kg; $P < 0.01$). L5P- and L8P-pigs were heavier at the end of the feeding trial than S5P- and S8P-pigs (25.03, 24.75 vs. 22.35, and 21.24 kg; $P < 0.01$). When overall ADG was evaluated, L8P-pigs were higher than S8P- and S5P-pigs, as well as L5P- and S8P-pigs were higher than S5P-pigs (0.47

vs. 0.44, 0.42 and 0.46, 0.44 vs. 0.42 kg/day respectively; $P < 0.01$). Pigs in the cooler nursery posted a higher overall ADG than pigs in the warmer nursery (0.45 vs. 0.43 kg/d; $P < 0.01$). This trial indicated: 1) feeding a higher energy diet to smaller than average pigs at weaning increased individual gains; 2) individual pig performance increased in a cooler nursery environment.

Key Words: Early Weaned Pigs, Temperature, Energy

322 Effects of cooked molasses blocks and inclusion of a fermentation or seaweed extract on in situ forage nutrient disappearance in steers fed low-quality hay. B. M. Johnson*, J. L. Leupp, J. S. Caton, G. P. Lardy, S. A. Soto-Navarro, and M. L. Bauer, *North Dakota State University*.

Five ruminally cannulated Holstein steers (376 \pm 8.1 kg) were used in a 5 x 5 Latin square to evaluate the effects of cooked molasses block supplementation and inclusion of a fermentation extract (*Aspergillus oryzae*) or a seaweed product (*Ascophyllum nodosum*) on in situ ruminal forage disappearance. All steers were offered a basal grass hay (6.0% CP, 75% NDF, and 43% ADF) diet ad libitum. Treatments were: no block (CON); block with no additive (40.5% CP; POS); block plus fermentation extract bolused directly into rumen (2.0 g/d; F); fermentation extract included in block (2.0 g/d; FB); and seaweed extract included in block (10 g/d; SB). Steers were housed individually and adapted to diets for 17 d before in situ incubations (98, 72, 48, 36, 24, 14, 9, 5, and 2 h). Determinations of in situ DM, CP, NDF, and ADF disappearance were conducted using Dacron bags. Dry matter, NDF, ADF, and CP were fit to non-linear models to estimate rate of digestion. In situ disappearance rate of hay DM (3.14 \pm 0.44%/h), NDF (3.18 \pm 0.47%/h), and ADF (3.02 \pm 0.51%/h) were not altered by treatment ($P \geq 0.46$). Seaweed extract increased ($P = 0.01$) the slowly degraded CP fraction compared with control block (39.5 vs 34.0 \pm 2.07%). Likewise, seaweed extract inclusion increased ($P = 0.01$) the potentially degraded CP fraction (74.2 vs 68.9 \pm 1.81%). Fermentation extract inclusion in the block increased ($P \leq 0.01$) the rapidly degraded (35.2 vs 31.9 \pm 0.77%) and the slowly degraded (39.7 vs 33.4 \pm 2.07%) CP fraction compared with providing fermentation extract separately. Degradation rate of CP was not affected by treatment. These data suggest that neither cooked molasses blocks or additive inclusion alters in situ rate of forage nutrient disappearance.

Key Words: Digestion Rate, Low-Quality Forage, Supplementation

323 Effect of creep feeding and season on intake and performance in nursing steer calves grazing native range in southeastern North Dakota. J. M. Benz*, J. J. Reed, J. S. Caton, and G. P. Lardy, *Department of Animal and Range Sciences, North Dakota State University*.

Nine ruminally cannulated and sixteen intact crossbred nursing steer calves (161 \pm 28 kg initial BW) were used to evaluate affects of creep feeding and advancing season on forage intake, diet quality, and performance. Treatments were no creep and creep fed at 0.45% BW (DM basis) daily. Creep feed consisted of 55% wheat midds, 38.7% soyhulls, 5% molasses, and 1.3% limestone. Three 14-d collection periods occurred in June, July, and August. Masticate samples were collected on d 1 of each period for diet quality analysis. Ruminal fluid was drawn on d 9 and used as inoculate for IVOMD analysis, which was coupled with fecal output to estimate forage intake. Forage OM intake increased ($P < 0.001$) linearly as season progressed; there was also a quadratic ($P < 0.001$) affect (1750, 1742, and 2490 \pm 106 g/d for June, July, and August, respectively). Forage OM intake tended ($P = 0.13$) to decrease in creep-fed calves compared with controls (2108 vs 1880 \pm 102 g/d respectively). Calf average daily gain was not affected ($P \geq 0.4$) by treatment

or period. Forage CP content decreased ($P < 0.001$) linearly as season progressed; there was also a quadratic effect (11.9, 12.8, and $7.7 \pm 0.5\%$, respectively). There was a quadratic ($P < 0.001$) effect for forage NDF (70.3, 64.9, and $69.7 \pm 1.1\%$, respectively). Forage IVOMD decreased ($P = 0.01$) linearly as season progressed; there was also a quadratic ($P = 0.02$) effect (63.4, 66.8, and $54.6 \pm 2.5\%$, respectively). Forage CP, NDF, and IVOMD were not ($P \geq 0.7$) affected by treatment. Data indicates that forage intake by nursing calves increases with advancing season, and is not affected by creep feed supplement. Grazed forage quality declines with advancing season in nursing beef calves.

Key Words: Nursing Calves, Forage Intake, Supplementation

324 Optimizing the interval from PGF to timed AI in the CoSynch+CIDR and 7-11 Synch estrus synchronization protocols for postpartum beef cows. V. R. Bremer*, S. M. Damiana, F. A. Ireland, D. B. Faulkner, and D. J. Kesler, *University of Illinois*.

The main objective of this experiment was to determine the optimal, yet practical, time to breed cows synchronized with CoSynch+CIDR and 7-11 Synch. A secondary objective was to determine any difference in pregnancy rates between the two protocols under field conditions. A fall breeding herd of 544 Angus x Simmental suckled beef cows managed at the University of Illinois Dixon Springs Agriculture Center in Simpson, IL was randomly assigned in a 2 x 3 factorial design. The main effects were method of synchronization and interval from PGF to timed AI (TAI). Cows synchronized with CoSynch+CIDR were administered GnRH at the same time as CIDR insertion. Seven d later CIDRs were removed and cows were administered PGF. Cows were inseminated at predetermined times (48, 54, and 66 h) using semen from commercial bull studs and concurrently administered GnRH. Cows synchronized with 7-11 Synch were fed 0.5 mg of MGA/head/d for seven d. The MGA was fed with ground corn at a rate of 0.45 kg/head/d. On the seventh d of MGA feeding all cows were administered PGF. Four d after PGF cows were administered GnRH followed by PGF seven d later. Cows administered the 7-11 Synch were assigned to one of the same three intervals from PGF to TAI. All injections were administered im in the neck. The doses of GnRH and PGF (Lutalyse) were 100 mg and 25 mg, respectively. The CIDRs contained 1.38 g of progesterone. Cows were examined for pregnancy via ultrasonography 32 to 37 d after the TAI. Only the treatment effect was significant ($P < 0.01$); time and the time x treatment interaction were not significant ($P < 0.20$). Pregnancy rates for cows synchronized with 7-11 Synch were 50%, 44%, and 52% when inseminated at 48, 54, and 66 h, respectively. Pregnancy rates for cows synchronized with CoSynch+CIDR were 56%, 67%, and 71% when inseminated at 48, 54, and 66 h, respectively. In summary, both CoSynch+CIDR and 7-11 Synch have relatively long intervals of time from PGF to TAI without compromising fertility; however, under these field conditions CoSynch+CIDR yielded higher pregnancy rates than 7-11 Synch.

Key Words: CoSynch+CIDR, 7-11 Synch, Estrus Synchronization

325 Vascular development of fetal placental cotyledons (COT) in single, twin and triplet pregnancies in sheep. J. M. Wirrenga*¹, P. P. Borowicz^{1,2}, J. S. Luther^{1,2}, D. Pant¹, D. A. Redmer^{1,2}, A. T. Grazul-Bilska¹, and L. P. Reynolds^{1,2}, ¹Department of Animal and Range Sciences, North Dakota State University, ²Center for Nutrition and Pregnancy, North Dakota State University.

Multiple fetuses may affect several parameters of the gravid uterus and placenta, including uterine blood flow and nutrient delivery. These latter two parameters depend to a large extent on growth (angiogenesis) of the placental vascular bed. To establish multiple pregnancies, two or three embryos on d 5 after IVF were transferred to recipients on d 5 after estrus. Gravid uteri were collected on day 140 of pregnancy after embryo transfer (n=3 ewes each for single, twin, and triplet pregnancies; normal length of gestation 145 days). For each ewe, several placentomes were fixed with Carnoy's solution by perfusion of the artery supplying the COT (fetal placental) tissue, and subsequently were perfused with a vascular casting resin (Mercox). Vascularity of COT was evaluated in tissue sections by image analysis (Image-Pro Plus) as described by Borowicz et al. (Biol. Reprod. 68[Suppl. 1]:150, 2003). Compared with singles, fetal weights were reduced ($P < 0.03$) in twins and triplets (5.78

vs. 5.26 and 4.17 ± 0.32 kg for singles, twins and triplets). Total placentome weight, however, was similar ($P=0.18$) among groups ($501, 383$ and 318 ± 61 g for singles, twins and triplets). Nevertheless, placental weight was correlated ($r = 0.65, P < 0.06$) with fetal weight. In addition, COT weight was correlated ($P < 0.04$) with both fetal and placental weight ($r = 0.69$ and 0.99 , respectively). Total COT vascular volume (ml per placenta) also was correlated ($r = 0.91, P < 0.01$) with placental weight. The number of COT capillaries per unit of placental tissue (i.e., COT vascular density) was negatively correlated ($r = -0.59, P < 0.10$) with fetal weight. These data indicate that reduced fetal and placental weights in twins and triplets, while reflected by reduced total COT vascular volume, were also associated with a compensatory increase in the number of COT capillaries per unit of tissue area. (Supported, in part, by NIH grant HL64141 to LPR and DAR, and ND SBARE grant to ATG-B, LPR and DAR)

Key Words: Vascularization, Placenta, Multiple Pregnancy

326 Development of a calpastatin biosensor to predict beef tenderness. S. L. Studer*, S. A. Grant, and C. L. Lorenzen, *University of Missouri*.

Accurate monitoring of the calpain enzymatic system is the key to a more accurate assessment of the overall tenderness and palatability of beef. Therefore, development of a biosensor that could accurately detect the presence and concentration of calpastatin levels would be a strong foundation for a new grading method. Calpastatin antibody (Ab) and protein A (PA) were each tagged with fluorescent dyes of Alexa Fluor 546 and Alexa Fluor 594, respectively. Ab and PA are added to a solution for binding to form a complex. Calpastatin antigen (Ag) was added to the solution containing Ab-PA complex. The Ag causes a conformational change in the Ab that can be detected by a spectrofluorometer. Several trials of this solution experiment were performed utilizing different ratios of Ab and Ag. The results are summarized in the table below. In each trial a non-specific control was performed to have a bases of comparison. The data illustrates that in each trial calpastatin was detected via a change in fluorescence. Furthermore, the experiment illustrated a potential of sensitivity to various calpastatin levels. This potential warrants further development of a calpastatin biosensor that would be effective in determining the tenderness of beef.

Changes in fluorescence intensity

Ratio of Ag to Ab	Specific	Non-specific	Change (%)
1:1 (66.7 nM)	1.016	.996	-2.08
1:2 (89 nM)	1.070	1.022	-4.67
1:5 (8.9 nM)	.996	.966	-3.06
1:10 (6.67 nM)	1.019	.991	-2.81
1:100 (.667 nM)	1.002	0.945	-6.11

Key Words: Beef, Tenderness, Calpastatin

327 Differential gene expression in proliferating and differentiating porcine skeletal muscle satellite cells. L. H. Bach*¹, N. E. Raney¹, M. E. Doumit¹, E. E. Helman¹, S. Zhao², C. K. Tuggle², and C. W. Ernst¹, ¹Department of Animal Science, Michigan State University, ²Department of Animal Science, Iowa State University.

DNA accretion is essential for growth and development of skeletal muscle. However, myotube and myofiber nuclei do not synthesize DNA. This need is fulfilled by myogenic satellite cells that proliferate, differentiate and fuse with adjacent muscle fibers. Gene expression changes associated with satellite cell differentiation are poorly understood. Therefore, the objective of this experiment is to identify differentially expressed genes in proliferating and differentiating porcine skeletal muscle satellite cells. Clonally derived satellite cells (4th passage; n=4 clones) were seeded onto gelatin-coated 60-mm culture dishes in MEM with 10% FBS, and allowed to proliferate for 5 d. Separate plates of each clone were then either induced to differentiate with serum-free medium (SFM) containing 10^{-6} M insulin (treated), or given SFM containing 10^{-9} M insulin (untreated). Cultures were maintained for 3 d and cells were harvested for total RNA isolation. Myogenin (MGN) mRNA abundance was evaluated in treated and untreated cultures by dot blot analysis. While variation in MGN mRNA abundance was observed between satellite cell clones, all cultures exhibited an increase in MGN mRNA after being induced to differentiate. RNA from two treated and two untreated clonal

populations was used to screen a cDNA macroarray containing 327 expressed sequence tag (EST) clones. Detectable levels of expression were observed for 240 ESTs, and initial data analysis revealed nearly 40% of these appear to be differentially expressed. Several extracellular matrix (ECM) protein genes appear to increase in treated cultures consistent with the need for increased motility of differentiating cells. The ECM gene fibronectin 1 (FN1) was selected for validation by dot blot analysis using the FN1 cDNA and an 18S rRNA loading control. Dot blot

results indicated that FN1 mRNA abundance was not significantly different between treated and untreated cultures. These results indicate that array technologies can be used to identify putative differentially expressed genes in satellite cells, but validation of array results is important for fully elucidating gene expression patterns.

Key Words: Pig, Macroarray