

**ABSTRACTS**  
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**\*Author presenting paper**

**Animal Behavior, Housing, Well-Being**

**1 Environmental factors impacting response to bovine viral diarrhea vaccines in Angus calves.** M. J. Schneider<sup>1</sup>, R. G. Tait, Jr.\*<sup>1</sup>, J. F. Ridpath<sup>2</sup>, and J. M. Reecy<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames, IA, USA*, <sup>2</sup>*National Animal Disease Center/ARS/USDA, Ames, IA, USA*.

The objective of this study was to evaluate the impact of environmental factors on the serological response to commercial bovine viral diarrhea type 2 (BVDV2) vaccinations in Angus cattle for inclusion as fixed effects into subsequent genetic evaluations for response to vaccination. This study utilized 353 Angus calves born in spring (n = 176) and fall (n = 177) calving seasons of 2006 in the Iowa State University Angus Breeding Project. Two vaccinations, initial and booster, were administered 3 weeks apart. Spring calves were weaned and given initial vaccination at the same time, while fall calves were weaned at the time of booster vaccination administration. Serum neutralization tests were conducted using cytopathic BVDV2 to measure titer level in all cattle. Titer levels at the time of first vaccination were not influenced by gender of calf (P = 0.13) but were influenced by calving group (P < 0.001) and calf age (P < 0.001). This observation may result from the decline of maternal antibodies transferred through colostrum with age. There was no interaction between group and age of calf covariate (P = 0.89) for titer level at the time of first vaccination, indicating maternal antibodies have a similar half-life in both groups. However there was a significant difference (P < 0.001) among groups for titer level following initial vaccination, with the group experiencing the stress of weaning at time of initial vaccination developing a lower titer level. Additionally, titer level at time of initial vaccination was a significant (P < 0.001) effect for predicting response to initial vaccination with animals having a higher initial titer level experiencing a smaller increase in titer change. Based on this initial study, we have adjusted experimental protocols for subsequent work to collect samples to evaluate individual animal rate of maternal antibody decline and to remove confounding of stress of weaning with calving season effects.

**Key Words:** beef cattle, health, vaccination

**2 Effect of maternal fear on pre-weaning mortality of piglets in a loose farrowing system.** Y.Z. Li\*, *University of Minnesota, Morris, MN, US*.

A study was conducted to test the hypothesis that fear of people in sows can affect maternal behavior and consequently affect pre-weaning mortality of piglets. Sows (n = 91; parity 1 to 10) from 4 breeding groups were tested in a human approach and a novel object approach test during wk 13 of gestation. Based on fear response, sows were classified into three categories: fearful sows that spent  $\geq 140$  s to approach a circle within 0.5 m of a person, least fearful sows that spent  $\leq 50$  s to approach the circle, and neutral sows ( $\geq 50$  s but  $\leq 140$  s). All sows farrowed in a group farrowing system where 8 sows shared a communal area, and farrowed in individual open pens. At farrowing, litter size was recorded. On a daily basis, dead piglets were weighed and removed. Piglets were weaned at 4 wk of age. Litter size data and pre-weaning mortality were analyzed by Proc GLIMIX and BW and ADG of individual pigs were analyzed by Proc MIXED with fear category as a fixed effect and parity and breeding group as random effects. There were no significant differences in the number of born alive and stillborn, birth weight of piglets, CV of birth weight within a litter, and pre-weaning growth rate of piglets among maternal fear categories (Table 1). Least fearful sows weaned more piglets than fearful sows (9.9 vs.  $8.3 \pm 0.86$ , P  $\leq 0.05$ ). These results support the hypothesis that fear of people in sows affected number of piglets weaned. Since least fearful sows weaned larger litters, selecting least fearful sows may increase the number of piglets weaned, especially in loose farrowing systems.

**Table 1. Sow performance in a loose farrowing system**

	Least fearful	Neutral	Fearful	SEM	P - value
# of litters	31	28	32		
Litter size, pigs/litter					
Born alive	11.4	10.9	10.6	1.03	0.68
Stillborn	0.6	0.7	0.8	0.30	0.83
Total dead	1.8	2.2	2.3	0.44	0.57
Weaned1	9.9a	9.2ab	8.3b	0.86	0.05
Mortality, %	14.9	17.2	21.0	3.92	0.31
Piglet growth					
Birth wt, g	1727	1632	1673	134.9	0.22
CV of birth wt, %	19.0	19.6	19.6	1.35	0.89
ADG (d0-weaning), g/d	262	258	263	8.3	0.80

<sup>1</sup>Means without a common superscript within a row differ ( $P < 0.05$ )

**Key Words:** sow fear, piglet mortality, loose farrowing

**3 Influence of corn coproducts on the behavioral repertoire of growing-finishing swine.** A. K. Johnson\*, L. J. Sadler, K. J. Stalder, and W. Powers, *Iowa State University, Ames.*

Byproducts of the ethanol industry have been receiving a great deal of attention as potential ingredients for swine diets to affect ammonia output. The objective of this experiment was to compare the acceptability of four different hemicellulose diets by the grow-finish pig through their behavior when dietary phases were changed. Pigs were observed over their growing-finishing phase of production, which was comprised of six different dietary formulation phases. Four treatments were compared: distillers dried grains plus solubles (DDGS), dehulled degermed corn (DDC), corn germ meal (CGM), and a traditional corn based diet (CORN). All diets were isocaloric and formulated to NRC recommendations. Pig behavior was recorded for 24 h post dietary change and video records was scored using a 5 min scan sampling technique by two experienced observers. Pigs were observed for two experienced observers. Pigs were observed for two behaviors (eating and drinking), two postures (active or inactive), or unknown (defined as when the pig could not be seen). A total of 8 chambers were used, housing 6 pigs each and one dietary treatment was applied to two chambers ( $n=2/trt$ ). A completely randomized experimental design was implemented and repeated measures were taken. Analyses were performed using the PROC Mixed procedure of SAS software for parametric data. Behavioral data was arcsine transformed to normalize the distribution prior to statistical analyses. The statistical model included the fixed effects of treatment, time and treatment by time interaction. Treatment by day were nested within chamber and was included as a random effect in the model. A repeated measure of day nested within pen was used and PDIFF was used to separate differences at a P-value of  $P < 0.05$ . Behaviors, postures and unknown for the growing-finishing pig throughout this trial were similar ( $P > 0.05$ ) across the treatment groups. In conclusion, differences in the hemicellulose content in the diet resulted in no changes to the pigs behavioral repertoire. However, due to the small number of chambers used, this work should be repeated to ascertain if no changes in the pig holds true when used commercially.

**Key Words:** behavior, coproducts, pigs

**4 Monitoring environmental conditions on a swine transport trailer.** C. M. Pilcher\*, C. M. Peterson, A. C. Lenkaitis, X. Wang, T. L. Funk, Y. Sun, and M. Ellis, *University of Illinois, Urbana.*

The objective of this project was to monitor environmental conditions on a swine transport trailer during transportation from the time of loading pigs at the farm, during the journey, to the time of unloading pigs at the plant under the range of typical external ambient conditions. A trailer of typical current design was equipped with instrumentation (located in the center of the ceiling of all 11 compartments) to measure internal temperature, relative humidity, air velocity, surface temperature of the inside surfaces of the trailer and of the pigs, and carbon dioxide concentration. Measurements were taken every 6 s during the journey on a total of 20 loads of pigs (156 pigs/load; average BW  $132 \pm 3.8$  kg; floor space on the trailer  $0.48 \pm 0.015$  m<sup>2</sup>/pig). Total time from start of loading to end of unloading averaged 5.5 h, and distance from farm to plant averaged 220 km. There was considerable variation in all environmental parameters between seasons and, also, within season, between decks and compartments of the trailer, and between stages of transportation. Average compartment temperature during the journey was lower ( $P < 0.001$ ) in winter than in the spring, fall, and summer (5.4 vs. 16.3 vs. 20.0 vs. 29.3 °C, respectively; SEM 2.13). The greatest range in temperature between compartments within the trailer was in winter when the average maximum difference between front and rear compartments at the start of the journey when the trailer left the farm was  $18.5 \pm 6.35$  °C (18.5 °C in the front vs. 0 °C in the rear). Changes in internal trailer temperature were generally greater at times when the trailer was stationary and air movement was limited, particularly during the period at the farm. Further research should focus on monitoring conditions at more locations within each compartment and also on measuring the direction as well as the velocity of air flow within the trailer.

**Key Words:** pig, transportation

**5 Impact of Paylean level and handling intensity on stress responses of market-weight pigs to a handling and transportation model.** C.M. Peterson\*<sup>1</sup>, C.M. Pilcher<sup>1</sup>, M.J. Ritter<sup>2</sup>, S.N. Carr<sup>2</sup>, J.N. Marchant-Forde<sup>3</sup>, and M. Ellis<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*Elanco Animal Health, Greenfield, IN*, <sup>3</sup>*USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN.*

This study investigated the impact of Paylean level and animal handling intensity on stress responses of market-weight pigs. A split-plot design was used with a 3 x 3 factorial arrangement of treatments: 1) Paylean Level (main plot; 0, 5, and 7.5 ppm); 2) Handling Intensity (sub-plot; gentle, moderate, and aggressive). A total of 288 pigs housed in groups of 8 (36 pens; 12 pens/Paylean Level) were fed Paylean for 28 d (98 to 130 kg BW) after which 6 pigs/pen (BW nearest to pen mean) were subjected to a standardized handling/transportation model. Pigs were moved a distance of 50 m using either 0, 4, or 8 shocks from an electric goad for the gentle, moderate, and aggressive handling treatments, respectively. Subsequently, pigs were transported on a livestock trailer at a floor space of 0.42 m<sup>2</sup>/pig in farm groups of 6 for a journey of ~1 h. Pigs were unloaded and moved a distance of 125 m using a livestock paddle and sorting board. Rectal temperature, blood acid-base parameters, and plasma cortisol, norepinephrine, and epinephrine were measured 2 h prior to the start of the Handling Intensity treatment (baseline) and immediately after the last handling procedure. Increasing handling intensity increased blood lactate ( $P < 0.001$ ) and reduced ( $P < 0.001$ ) blood bicarbonate and pH values. Moderate and aggressive compared to gentle handling increased ( $P < 0.001$ ) plasma cortisol and norepinephrine. Pigs fed 5 ppm of Paylean did not differ ( $P > 0.05$ ) from

the control pigs for any of the parameters measured. However, pigs fed 7.5 ppm of Paylean had higher ( $P<0.05$ ) plasma epinephrine levels compared to the control. These results confirm the negative effects of aggressive handling on stress-related blood acid-base measures and plasma hormones. Feeding Paylean had no effect on blood acid-base responses to handling and transportation, but plasma epinephrine levels were increased at the 7.5 ppm level.

**Key Words:** pig, Paylean, handling

**7 Effects of diet source and timing of porcine circovirus type 2 (PCV2) and *Mycoplasma hyopneumoniae* (Mpp) vaccines on post-weaning nursery pig performance.** E. M. Kane\*, M. L. Potter, J. R. Bergstrom, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

A total of 400 weanling pigs (21 d old; 5.7 kg BW) were used in a 20-d growth trial to determine the effect of diet source and PCV2 and Mpp vaccination timing on growth performance. Comparisons between diet source (A, B, C, or D) and vaccination timing (d 0 or 8 after weaning) were made in a  $4 \times 2$  factorial arrangement in a randomized complete block design (5 pigs/pen; 10 pens/treatment). Pigs were fed 0.45 kg/pig of SEW diet, and then a transition diet to d 8. A common third diet was fed to all pigs from d 8 to 20. Formulated to similar specifications, the SEW and transition diets were supplied by 4 different manufacturers. On d 0 or 8, vaccines (PCV2: Circumvent PCV, Intervet; Mpp: RespiSure-One, Pfizer) were administered as labeled. Pigs were weighed and feed disappearance measured on d 0, 4, 8, and 20. There were no 2-way interactions for ADG or ADFI. From d 0 to 8, pigs fed diet sources A and B had greater ( $P<0.01$ ) ADG and ADFI than pigs fed diet source C with pigs fed diet source D having lower ( $P<0.02$ ) ADG and ADFI than pigs fed diet source B. On d 8, pigs fed diet sources A and B were heavier (7.4 kg) than pigs fed diet sources C (7.1 kg) or D (7.2 kg). There were no effects of SEW and transition diet source fed on performance from d 8 to 20. From d 0 to 8, pigs vaccinated on d 0 had decreased ADG ( $P<0.01$ ; 0.19 vs. 0.21 kg), ADFI ( $P<0.01$ ; 0.17 vs. 0.18 kg), and lower d 8 weights ( $P<0.01$ ; 7.2 vs. 7.4 kg) compared with pigs vaccinated on d 8. From d 8 to 20, pigs vaccinated on d 8 had decreased ( $P=0.05$ ; 0.31 vs. 0.32 kg) ADG compared to d 0 vaccinates. In summary, diet source influenced pig performance, despite similar ingredient and nutrient specifications. Also, the vaccines used in this study reduced feed intake and growth immediately after vaccination. The impact of vaccination timing and diet source on pig performance should be considered when investigating performance issues in the nursery.

**Key Words:** PCV2, vaccine, nursery pig

**8 Effects of porcine circovirus type 2 and *Mycoplasma hyopneumoniae* vaccines on nursery pig performance.** M. L. Potter\*, A. W. Duttlinger, J. R. Bergstrom, S. S. Dritz, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

Nursery pigs are often vaccinated for porcine circovirus type 2 (PCV2) and *Mycoplasma hyopneumoniae* (*M. hyo*). Concurrent with the introduction of PCV2 vaccines, producer reports indicate increased difficulty getting pigs to eat after weaning. These reports prompted this trial to evaluate PCV2 and *M. hyo* vaccine effects on nursery pig performance. A total of 360 pigs (21 d old; 5.9 kg BW) were blocked by BW and used in a 35-d study to evaluate two commercial PCV2 vaccines: Circumvent PCV (CV; Intervet) and CircoFLEX (CF; Boehringer Ingelheim), and

one *M. hyo* product: RespiSure (MYCO; Pfizer). Comparisons between PCV2 (CV, CF, or control) and *M. hyo* (MYCO or control) vaccines were made in a  $3 \times 2$  factorial in a randomized complete block design (5 pigs/pen; 12 pens/treatment). Vaccines were administered according to label directions; CV at weaning; CV and MYCO at weaning and 21-d later. Similar diets were fed to all pigs. Pigs were weighed and feed disappearance determined on d 0, 4, 8, 14, 21, 25, 29, and 35 to calculate ADG, ADFI, and G:F. No 2-way interactions were observed ( $P<0.05$ ). Overall, CV vaccinated pigs had decreased ADG ( $P<0.02$ ; 0.39 vs. 0.41 and 0.41 kg) and ADFI ( $P\leq 0.01$ ; 0.56 vs. 0.60 and 0.59 kg) compared with CF and control pigs, respectively. On d 35, CV pigs weighed less ( $P<0.01$ ; 19.5 kg) than CF (20.1 kg) or control pigs (20.1 kg). MYCO vaccinated pigs had lower ADG than controls ( $P<0.05$ ) from d 14 to 21 (0.46 vs. 0.48 kg) and d 21 to 25 (0.42 vs. 0.46 kg). On d 35, MYCO vaccinated pigs tended to weigh less ( $P=0.06$ ; 19.7 vs. 20.1 kg) and have lower ADFI ( $P=0.06$ ; 0.57 vs. 0.59 kg) than controls. These data indicate that PCV2 and *M. hyo* vaccination can independently reduce feed intake and performance of nursery pigs, with the PCV2 vaccine impact being product-dependent. Although PCV2 and *M. hyo* vaccines are known to improve finishing performance, negative impacts on nursery performance must be considered when implementing vaccine strategies.

**Key Words:** growth, pig, vaccine

**9 The effect of supplementing dry feed with a nutritional gel additive at the time of vaccination on nursery pig behavior.** J. Kline\*<sup>1</sup>, A. Johnson<sup>1</sup>, R. Witte<sup>1</sup>, L. Sadler<sup>1</sup>, B. de Rodas<sup>2</sup>, D. Brown<sup>2</sup>, L. Layman<sup>1</sup>, W. Holt<sup>1</sup>, L. Karriker<sup>1</sup>, and K. Stalder<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Land O Lakes Purina Feed, Gray Summit, MO*.

An experiment involving 64 weanling pigs (4.2 kg BW) was conducted to determine if feeding a nutritional gel supplement when vaccinated altered behavior. Pigs were sorted by size and sex and penned in groups of four (4 pens/treatment) in an off-site nursery. Dietary treatments were applied to pens in a 2x2 factorial arrangement. First factor was with and without vaccination and second factor was with and without the nutritional gel supplementation. Pigs in the vaccinated groups received a single dose commercial *Mycoplasma hyopneumoniae* killed bacterin (2 cc vaccine/pig) on day 10 post-weaning and pigs on the gel group received the nutritional supplementation in a gel form (UltraCare® Gel) on d 9 to 11 post-weaning. All pigs were fed common Phase 1 (d 0 to 7) and phase 2 (d 8 to 14) diets. Scoring of video began at 10:00 am on day 9 and ended at 10:00 am on day 11. One day prior to recording of behavior, all pigs in a pen were identified with an individual number placed on the back between the scapulas. One 12 v black and white CCTV recorded at 10 fps and the acquisition of two postures (active and inactive) and two behaviors (at drinker and feeding station) were collected by two experienced observers who viewed the DVDs utilizing a 10 min scan sampling technique. There were no differences between treatments for active ( $P=0.60$ ), inactive ( $P=0.99$ ) or at drinker ( $P=0.37$ ), respectively. There was a difference ( $P=0.0085$ ) between treatments for the percentage of time at the feeding stations with pigs receiving vaccine and no gel spending the least amount of time at the feeding stations ( $6.86\pm 0.43\%$ ) compared to pigs that received the gel / no vaccine ( $9.11\pm 0.43\%$ ) and gel / vaccine ( $9.07\pm 1.43\%$ ). Therefore, the availability of a gel product when pigs are either vaccinated or not provided some benefit, as the time spent at the feeding station was increased compared to pigs that did not have access to the gel.

**Key Words:** gel, pigs, vaccination

**10 Evaluation of a pre-molt calcium and low-energy diet molting program: effects on behavior.** E. R. Dickey, K. Bregendahl, and A. K. Johnson\*, *Iowa State University, Ames.*

Concern over individual hen well-being has been expressed by numerous groups who oppose the traditional methodology of withdrawing feed to induce molt in the laying hen. The objectives of this study were to compare the behavior of the laying hen in a cage system when offered (a) a pre-molt calcium treatment and (b) low-energy diets versus a traditional feed-withdrawal during and after an induced molt. A total of 144 Hy-Line W-36 laying hens (85 wk of age, 1.67 Iowa State University 0.2 kg) housed three per cage (413 cm<sup>2</sup> / hen) were used. Six treatments were compared in a two (fine versus coarse calcium treatment) by three (feed withdrawal, soybean hulls, or wheat middlings) factorial design. The Ca in the pre-molt treatment was a supplement to a commercial laying hen diet and differed only in particle size (fine 0.14 and coarse 2.27 mm in diameter). Two postures (sitting and active) and five behaviors (feeding, drinking, preening, non-nutritive pecking, and aggression) were observed once during baseline (before molt) and twice during molt for 2 h in the morning and 2 h in the evening. The cage was the experimental unit and the data over a day of observation and within a period were averaged. Data were analyzed using the PROC MIXED procedure of SAS with  $P < 0.05$  significant. There were no differences ( $P > 0.05$ ) for postures or behaviors during baseline. There were no ( $P > 0.05$ ) carry over effects of the Ca treatment on subsequent behaviors and postures collected during molt. Feed withdrawal hens were more ( $P < 0.05$ ) active and ate and drank less often compared to soybean hull and wheat middling hens, but there were no ( $P > 0.05$ ) differences in aggression, non-nutritive pecking or sitting. Soybean hull hens spent more ( $P < 0.05$ ) time preening and feeding than the feed withdrawal and wheat middling hens. In conclusion, a pre-molt calcium treatment did not affect the behaviors and postures of the laying hen during molt. Low-energy diets did not adversely affect the behaviors and postures of the laying hen and can therefore be a useful alternative to feed withdrawal.

**Key Words:** behavior, laying hen, molt

**11 Piglet mortality in an outdoor farrowing hut: What behaviors contribute to their demise over the first 72-h?** J. Garvey<sup>1</sup>, J. J. McGlone<sup>2</sup>, K. J. Stalder<sup>1</sup>, L. J. Sadler\*<sup>1</sup>, and A. K. Johnson<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Texas Tech University, Lubbock, TX.*

The majority of piglet mortalities occur in the first 72-h after parturition with 50% attributed to crushing by the sow. Pre-weaning crushing has been estimated to cost the industry over \$100 million/yr and is a piglet welfare concern. The objective of this study was to determine differences in the behavioral repertoire for piglets that were crushed or not crushed by the sow over the first 72-h following parturition. Eight litters (PIC, C-22, USA) were housed in English-style farrowing huts, bedded with wheat straw and had a metal fender. Two treatments were compared; piglets that were crushed (CR) and piglets that lived (NC). One behavior (nursing), two postures (active and inactive) and one unknown category (defined as piglet could not be seen) were recorded. Data was collected by one experienced observer viewing videos recorded at 2.5 frames per second using a 10 minute scan sample and data was entered into Microsoft Excel. Data was square root arcsine transformed and analyzed using PROC MIXED of SAS. The experimental unit was the farrowing hut (containing one litter). The model included the parameter of interest and treatment, a random statement of block nested with treatment and a repeated measures statement of day nested within sow. No differences were observed for nursing ( $P = 0.69$ ; 26.26 + 2.42 % CR vs. 27.88 + 2.42 % NC), inactive ( $P = 0.59$ ; 55.37 + 2.60 % CR vs. 53.24 + 2.60

% NC), active ( $P = 0.52$ ; 15.48 + 1.04 % CR vs. 16.42 + 1.04 % NC) and unknown ( $P = 0.78$ ; 2.89 + 0.54 % CR vs. 2.46 + 0.54 % NC), respectively. In conclusion, there were no differences in the behavioral repertoire performed by outdoor loose housed piglets that resulted in their death over the first 72-h after parturition. In conclusion, finding few behavioral differences between treatments may indicate that variation among sow behavior is a more significant cause of piglet crushing than variation among piglet behaviors.

**Key Words:** behavior, mortality, piglet

**12 Analysis of the agreement between locomotion score and culling due to lameness among culled sows in commercial farms.** Y. Sasaki<sup>1</sup>, S. S. Anil\*<sup>2</sup>, L. Anil<sup>2</sup>, J. Deen<sup>2</sup>, M. E. Wilson<sup>3</sup>, and T.L. Ward<sup>3</sup>, <sup>1</sup>*Meiji University, Kanagawa, Japan 214-8571*, <sup>2</sup>*University of Minnesota, St. Paul*, <sup>3</sup>*Zinpro Corporation, Eden Prairie, MN.*

Lameness is an important reason for premature sow removals. This study analyzed the agreement between locomotion score and culling reasons in 2 commercial farms using records of 336 sows culled during March to May 2008. Locomotion was scored (range: 0, non-lame to 3, severely lame) when sows were moved out from the farrowing room after farrowing. Reasons for culling were grouped into lameness, old age, reproductive problems and other reasons. The degree of agreement between locomotion score and culling due to lameness was analyzed using the kappa statistics in SAS. For this analysis, locomotion score was grouped into 0 to 1 or 2 to 3, and the reasons were categorized into lameness or other reasons. The relative frequency of locomotion scores were 36.9, 49.4, 10.4, and 3.3% for scores 0, 1, 2 and 3 respectively. Among the sows culled for lameness, relative frequency of locomotion score for score 0, 1, 2, and 3 were 18.2, 50.6, 28.6, and 2.6%, respectively. Of the 46 sows having locomotion score 2 to 3, 52.2% were culled for lameness. Of the 290 sows having locomotion score 0 to 1, 18.3% were culled for lameness. Among the 22 sows having locomotion score 2 to 3 but not culled for lameness, 36.4% and 13.6% were culled for reproductive problem and old age, respectively. The kappa coefficient was 0.26 (95% confidence interval: 0.14 to 0.39). The values of kappa statistic range from +1 (perfect agreement) via 0 (no agreement above that expected by chance) to -1 (complete disagreement). A kappa statistic between 0 and 0.5 is considered to be indicative of poor agreement between locomotion score and lameness as a removal reason among removed sows. The study indicated that a considerable proportion (47.8%) of culled sows with severe lameness was culled for reasons other than lameness. It could be that lameness predisposed the sows to more serious reproductive inefficiencies subsequently that led to their removal for those reasons.

**Key Words:** lameness, locomotion scoring, culling reasons

**13 Drinker to nursery pig ratio: Effects on behavior.** C. Jackson<sup>1</sup>, K. Stalder<sup>1</sup>, L. Sadler<sup>1</sup>, R. Edler<sup>2</sup>, J. Holck<sup>2</sup>, P. DuBois<sup>3</sup>, L. Karriker<sup>1</sup>, and A. Johnson\*<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Boehringer Ingelheim Vetmedica, Ames, IA*, <sup>3</sup>*Cargill Pork, Wichita, KS.*

The objectives of this study were to determine the number and duration of drinking visits, pig preference for a water bowl location and the level of aggressive interactions when pigs were offered one (next to feeder), two (feeder and opposite feeder) or three (feeder, opposite and alley) water bowl drinkers/pen. A total of 225 crossbred (21 ± 4 d of age, 5.38 ± 2.65 kg) pigs were housed in nine single sex pens (25 gilts per pen). This study was conducted at a commercial nursery facility that had a natural light cycle. Pigs had ad-lib access to water, delivered through a single

stainless steel nipple cup drinker. Three treatments were compared; TRT 1; one cup (n=3), TRT 2; two cups (n=3) and TRT 3; three cups (n=3) per pen. One 12 V black and white camera was positioned over each drinker and drinking behavior, preference and aggression was recorded from 0700 to 1300 h onto a DVR at 1 fps. The acquisition of behavior was obtained by an experienced observer who viewed the recordings continuously using Observer. The experimental unit was the nursery pen and the total number and length of visits, total number and length of aggressive interactions and water bowl preference were analyzed using the PROC MIXED procedure of SAS. The model included the fixed effect of treatment and a weight block as a linear covariate. Pen nested within treatment and day was included as a random effect in the model. Total number of drinking visits differed (P=0.02) with pigs from TRT 1 and TRT 2 having fewer visits to the water bowl drinker than TRT 3. Total length of time, total number of aggressive interactions and length of aggression around the water bowl drinker was not (P > 0.05) different between treatments. Pigs did not (P = 0.47) show a preference for water bowl location when offered two, but did show a preference (P < 0.01) when offered three water bowl drinkers per pen. The water bowl closest to the alley was the least preferred. In conclusion, when offered more places to drink pigs visited the water bowl drinker more often. Nursery pigs displayed a water bowl drinker preference with the alley location being the least favored.

**Key Words:** behavior, drinking, pig

**14 Effects of moving market weight pigs in different group sizes during loading on stress responses and transport losses at the packing plant.** N. L. Berry\*<sup>1</sup>, M. Ritter<sup>2</sup>, E. Brunton<sup>1</sup>, W. Stremsterfer<sup>1</sup>, B. Hoag<sup>1</sup>, J. Wolfe<sup>1</sup>, N. Fitzgerald<sup>1</sup>, M. Porth<sup>1</sup>, D. Delaney<sup>1</sup>, and T. Weldon<sup>1</sup>, <sup>1</sup>Cargill, Inc., Coralville, IA, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Forty five trailer loads of pigs (mean BW = 119.9 kg ± 0.53) were utilized in a randomized complete block design to evaluate the effects of moving pigs in two different group sizes (small [groups of 4] vs. large [groups of 8]) during loading on stress responses (during loading and unloading) and transport losses at the plant. The study was conducted on 4 wean-to-finish sites within 1 production system. The length of the barns and the width of the center aisles were 61 m and 76 cm, respectively. During loading, treatments were randomly assigned to trailer decks. Pigs were loaded in groups of 4 or 8 using sorting boards and, if necessary, electric prods. Pigs were transported ~2.5 h to the plant on pot-belly trailers at a floor space allowance of 0.42 m<sup>2</sup>/pig. Pigs were unloaded by using livestock paddles. The number of pigs exhibiting open-mouth breathing, skin discoloration and muscle tremors were recorded during loading and unloading. Also, the number of dead (at the plant) and non-ambulatory pigs (at the farm and at the plant) were recorded. Total losses were defined as the sum of dead and non-ambulatory pigs at the plant. Data were transformed and analyzed by using PROC Rank and PROC Mixed of SAS. Pigs moved in small groups required less (P < 0.01) time to load and had lower (P ≤ 0.05) frequencies of open-mouth breathing and skin discoloration during loading and unloading. Furthermore, pigs loaded at the farm in small groups had lower (P < 0.01) rates of dead and non-ambulatory pigs at the plant resulting in fewer (P < 0.01) total losses than pigs loaded in large groups. These data confirm that group size during loading has a major impact on physical signs of stress during loading and unloading, as well as transport losses at the plant.

**Table 1. Effects of group size during loading on stress responses and transport losses.**

Trait	Small Groups	Large Groups	SEM	P-Value
Loading observations				
-Loading time, min	21.28	25.87	1.26	0.01
-Open-mouth breathing, %	8.24	18.56	1.16	0.01
-Skin discoloration, %	6.71	15.01	1.04	0.01
-Muscle tremors, %	0.08	0.63	0.11	0.01
-Non-ambulatory at farm, %	0.05	0.27	0.07	0.05
Unloading observations				
-Open-mouth breathing, %	2.80	4.61	0.47	0.01
-Skin discoloration, %	0.39	0.90	0.16	0.05
-Muscle tremors, %	0.03	0.10	0.04	0.20
Transport losses at plant				
-Dead, %	0.19	0.56	0.09	0.01
-Non-ambulatory, %	0.36	0.70	0.09	0.01
-Total losses, %	0.55	1.26	0.15	0.01

Total losses = Dead + Non-ambulatory

**Key Words:** pig, handling, transport losses

**15 Variation in temperature within trucks transporting pigs during two seasons in two locations.** S. Hayne\*<sup>1</sup>, T. Samarakone<sup>1</sup>, T. Crowe<sup>2</sup>, S. Torrey<sup>3</sup>, R. Bergeron<sup>4</sup>, T. Widowski<sup>4</sup>, N. Lewis<sup>5</sup>, C. Dewey<sup>4</sup>, L. Faucitano<sup>3</sup>, and H. Gonyou<sup>1,2</sup>, <sup>1</sup>Prairie Swine Centre, Saskatoon, SK, Canada, <sup>2</sup>University of Saskatchewan, Saskatoon, SK, <sup>3</sup>Agriculture and Agri-Food Canada, Sherbrooke, QC, <sup>4</sup>University of Guelph, Guelph, ON, <sup>5</sup>University of Manitoba, Winnipeg, MB.

Temperatures were recorded at 5-min intervals within each truck compartment to determine conditions during transport of pigs at two locations, Saskatchewan (West) and Quebec (East), during both summer and winter (6 replicates). A three-deck pot-belly truck (PB) was used in the West, while both a PB and a double-deck truck (DD) were used in the East. Data were analyzed separately for each location. In the West, ambient temperatures at loading (21:00 h) ranged from 7.4 to 22.9 C and -24.5 to -3.8 C in summer and winter, respectively. The average temperature within the truck ranged from 17.3 to 26.4 C and 6.2 to 16.4 C prior to departure in the summer and winter, respectively, and did not differ among compartments. The average temperature during transport ranged from 15.7 to 22.0 C and -3.3 to 4.3 C during summer and winter, respectively. Overall, during transport, the highest temperature was in the front compartment of the middle deck (14.2 C), the lowest temperature in the upper deck (6.5 C), and intermediate in the remainder of the middle and lower decks (12.3 C) (P<0.05). In the East, ambient temperatures at loading (05:00 h) ranged from 15.1 to 23.6 C and -12.8 to 3.1 C during summer and winter, respectively. Overall, the DD was cooler (18.2 C) than the PB (20.0 C) just prior to departure (P<0.05), but no interactions among season, compartment or truck type were found. Within the PB truck, summer and winter temperatures prior to departure ranged from 23.7 to 30.4 C and 9.3 to 20.4 C, respectively. The coolest compartments were in the upper level and the rear middle (18.9 C), compared to the front middle and lower compartments (22.4 C) (P<0.05). Temperatures during transport in summer and winter ranged from 23.2 to 28.6 C and -0.1 to 10.8 C, respectively. The coolest compartments were in the upper level (14.7 C), and the warmest was in the front lower level (18.9 C) (P<0.05). The temperature conditions during transport vary considerably between seasons and among compartments within a vehicle.

**Key Words:** swine, transportation, temperature

**16 Analysis of stress associated with a newly designed mechanical restraint for pigs.** L. Anil<sup>1</sup>, S. S. Anil<sup>1</sup>, J. Deen\*<sup>1</sup>, M. E. Wilson<sup>2</sup>, and T. L. Ward<sup>2</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Zinpro Corporation, Eden Prairie, MN.

It is important to minimize the stress associated with restraining in swine herds. Commonly used method of snaring is stressful and labor intensive. This study assessed the stress level in terms of salivary cortisol (SC), heart rate (HR-beats/min), vocalization and level of struggling of sows that are restrained mechanically (entry to chute, being lifted up, and dropped down) compared to sows not restrained in their home pens/stalls. The study involved sows (60-65 d of gestation) housed pens (23) and in stalls (27). Heart rate was measured 5 min prior to entering the chute while the sow was in its pen/stall, 1 min after entering the chute, 1 min after being lifted and 1 min after bringing down the sow. Saliva samples were collected immediately after HR recording. The levels of struggling and vocalizations when the animals were lifted up (for 3 min) were assessed. The data were analyzed using repeated measures (PROC MIXED, SAS v 9.1). The SC and HR were lower ( $P \leq 0.05$ ) when the sows were in the home pen/stall compared to the stages of restraint. The SC and HR were similar at different stages after entering the restraint. Sows in pens had lower HR than sows in stalls ( $P \leq 0.05$ ). The SC was higher ( $P \leq 0.05$ ) in pen-housed sows compared to stall-housed sows. The SC of pen-housed sows at different stages of restraint was similar. The SC of pen-housed sows at all stages were similar to that of stall-housed sows at lifted-up and dropped down stages. The SC of stall-housed sows in the stall was lower ( $P \leq 0.05$ ) compared to their SC at other stages of restraint and it was lower ( $P \leq 0.05$ ) than the SC of pen-housed sows at all stages of restraint. The HR of stall-housed sows at lifted-up position and that after bringing them down were higher ( $P \leq 0.05$ ) than that at the pre-lifting and in stall. The HR of stall-housed sows at lifted-up position and after bringing them down were similar and were higher ( $P \leq 0.05$ ) than pen-housed sows. Struggling scores and vocalizations during restraint were higher ( $P \leq 0.05$ ) in stall-housed sows. Further studies are needed to analyze the effect of prior exposure and housing system on the stress level associated with the new devise.

**Key Words:** stress, restraint, cortisol

**17 The effect of housing facilities on steer behavior and temperament during the winter.** R. Baker\*, A. Johnson, L. Sadler, K. Stalder, and M. Honeyman, Iowa State University, Ames.

The objective of this study was to determine if steer behavior and temperament differed when housed in a deep bedded hoop barn vs. a conventional feedlot. Total of 240 crossbred Bos taurus steers were used (December 2006 to April 2007). Steers were housed in either one deep bedded hoop barn (HP; n=3 pens; 4.65m<sup>2</sup>/steer) or one conventional feedlot (FD; n=3 pens 14.7m<sup>2</sup>/steer). Steers were ear tagged, implanted, and weighed (400±23.4kg) on arrival and allotted to housing system by weight. All steers were fed a balanced diet and had ad libitum water access from one drinker/pen. Duration for behavioral data was collected using a 10-min scan sample using live observation by two experienced observers from 0800h to 1600h on d40, 76 and 119 of the trial. Two behaviors (head in bunk and waterer) and three postures (lying, walking and standing) were recorded. The day post-behavior collection, steers were moved through a chute for temperament scoring. Scores ranged from 1 (calm) to 6 (wild). Behavioral data was normalized and analyzed

using PROC MIXED of SAS. Temperament scores were analyzed using PROC GLIMMIX of SAS. Duration of time for head in bunk was greater for HP vs. FD steers ( $P=0.04$ ). There was no ( $P=0.66$ ) difference for steer head in waterer between housing treatments. Lying duration was greater ( $P=0.008$ ) for HP vs. FD steers. The HP steers exhibited less duration of time engaged in walking ( $P=0.003$ ) and standing ( $P=0.008$ ) compared to FD steers. Temperament scores were different between treatments with HP steers scoring lower (more calm) than FD steers ( $P=0.03$ ). Scores increased over the first two observation days and decreased on the third day ( $P<0.001$ ). Day by treatment was not different ( $P=0.46$ ). In conclusion, duration of time differed for HP steers being less active but more time was spent with head in bunk. Steer temperament at exit differed with HP steers scoring more calmly. Furthermore, temperament score was lower (calmer) on the final day of observation. Therefore, housing steers in a bedded hoop barn does not result in adverse behavior or temperament alterations and can be considered as a useful housing alternative for finishing steers by beef producers.

**Key Words:** behavior, steers

**20 CAST issue paper: Sow welfare in individual gestation accommodation.** S. E. Curtis\*<sup>1</sup>, R. B. Baker<sup>2</sup>, M. J. Estienne<sup>3</sup>, P. B. Lynch<sup>4</sup>, J. J. McGlone<sup>5</sup>, and B. K. Pedersen<sup>6</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Iowa State University, Ames, <sup>3</sup>Virginia Polytechnic and State University, Blacksburg, <sup>4</sup>Moorepark Research Centre, Ireland, <sup>5</sup>Texas Tech University, Lubbock, <sup>6</sup>Danish Farm Design, A/S.

An international Task Force assembled by the Council for Agricultural Science and Technology prepared an Issue Paper, *Sow Welfare in Individual Gestation Accommodation* (crate or stall = IGA), accessible at [www.cast-science.org](http://www.cast-science.org). Scientific evidence was critically evaluated: design and analysis of IGA for behavior, feeding, reproduction, health, zoonoses, ergonomics, worker safety, and manure management. Numerous reports exist, but quality of experimental design and conduct and industry relevance was often lacking. Too few statistically adequate, scientifically controlled trials on industry farms have been conducted; many reports are not useful for critical evaluation, let alone developing public policy. Examples: (1) Several IGA systems have been proposed (e.g., turn-around crate, flexible-width and -length crate); pilot-study results suggest some hold promise as alternatives to straight, nonflexible crates but need further development. (2) Feeding-systems comparisons have yielded mixed results. (3) Important basic questions remain (e.g., in group pens, what is the optimal number of sows/group and how can social stress be reduced?) (4) Inadequate attention has been paid to inter-system comparison of sow health or caretaker health and safety. Recent reviews indicate that welfare can be equivalent in IGA and group pens. But citizen views diverge from this. Two questions emerge: (1) Because production costs are lower with IGA, and given world hunger and economic pressures, should IGA be refined in attempts to improve sow welfare in IGA? (2) Because welfare can be equivalent in IGA and group pens, yet vocal citizens favor pens, should pens be redesigned in an attempt to decrease social stress and production costs? Both? More large-scale, on-farm, multidisciplinary, scientifically robust research and development are indicated before rigid regulations—which would increase production costs but not necessarily sow welfare—should be imposed.

**Key Words:** pig, sow housing, welfare

## Billy N. Day Symposium: Utilization of Technology to Enhance Pig Reproductive Performance

### 21 Current practices for evaluating boar semen: their usefulness and limitations. D. G. Levis\*, *University of Nebraska, Concord.*

It has been reported that 20,000 boars are housed in about 120 boar studs within the USA. It is not uncommon for raw ejaculates to enter the semen processing laboratory at an interval of 3 to 5 minutes; thus, the raw ejaculates have to be processed quickly. The most commonly used tests for evaluating sperm quality of ejaculates involve visual estimations of the percentage of motile and morphologically normal spermatozoa. The use of these characteristics usually identifies very poor samples but does not always identify sub-fertile samples. A common practice within a boar stud is to adjust the total number of spermatozoa per dose based on sperm motility and morphology. Sperm motility is estimated subjectively at 100 to 400x; but, the accuracy of the outcome depends on individuals. Motility is used to establish the lower limit of acceptability for semen to be processed. Gross defects of the sperm head and tail structures are subjectively identified by technicians using stained or unstained samples on a light microscope. Although computer-assisted semen analysis systems are used to enhance accuracy of estimating sperm motility and morphological defects, these instruments are not widely used in commercial practice. Concentration of sperm cells is predominately estimated by photometer; however, some boar studs have difficulty maintaining accurate estimations. A few studs evaluate the raw semen sample for the presence of bacteria. All doses of semen produced by a boar stud are not highly fertile. The level of fertility among individual boars is variable. Semen characteristics such as normal acrosomes, normal head and tail morphology and progressive forward motility have a positive relationship with boar fertility in some cases, but not in other cases. When using homospermic semen the appropriate number of sperm cells per dose has been shown to vary among boars. There is not a quick way to determine the appropriate number of sperm per dose; thus, at least 60% of the boar studs pool semen. More research is needed to improve accuracy of semen assessment in a boar stud.

**Key Words:** boar, semen, evaluation

### 22 Fourier harmonics to determine the relationship between sperm nuclear shape and boar fertility. J. J. Parrish\*, *University of Wisconsin, Madison.*

The concepts of compensable and uncompensable sperm defects have not been widely applied to boar semen. Many traditional tests that evaluate boar semen quality focus on compensable traits such as motility or viability. These are characteristics that if low can be overcome by increasing the number of sperm inseminated. In contrast, uncompensable traits are not overcome by increasing sperm insemination dose. Given the high dose of sperm used for swine artificial insemination, it should be uncompensable defects in sperm that should most highly related to fertility. In the bovine, the Parrish lab has developed a method to examine nuclear shape of sperm that reflects an uncompensable trait of semen, namely the ability of sperm to sustain embryo or fetal development once fertilization occurs. To obtain the nuclear shape, sperm are stained with DNA binding fluorescent dyes and then imaged. Customized software is then used to obtain nuclear perimeter coordinates on at least 100 sperm. The coordinates are converted in statistical analysis software to a Fourier series and finally the Fourier Harmonic Amplitudes (FHA) are calculated for harmonics 0 - 5. These measures are objective and orthogonal measures of shape. In the bovine, the FHA are used as predictors of bull fertility. When applied to boar sperm, from a group of 26

boars, the FHA in combination with motility and viability was able to correctly identify the bottom 2 boars having a fertility (farrowing rate) of < 1 SD below the mean. It incorrectly identified 1 adequate fertility boar as being of low fertility. The approach has identified seasonal changes in boar sperm shape as well identifying nuclear shape changes associated with increased temperatures but also other changes to yet unknown environmental effects. The FHA approach has the potential to allow the identification of subfertile males prior to their use in artificial insemination or could be incorporated into a selection index of boars at a nucleus herd.

### 23 Use of embryo transfer to preserve pig genetics. S. L. Terlouw\*, B. A. Didion, and J. R. Dobrinsky, *Minitube of America, Verona, WI.*

Profitable swine production requires a consistent supply of healthy replacement genetics. Disruption of genetic supply by a known or unknown pathogen(s) requires eliminating the pathogen(s), managing the disease(s) or removing the genotype from the pathogen(s). The objectives of two cases were to use embryo transfer to avoid transmission of unknown pathogens during genetic relocation of healthy animals (C1, Babcock Genetics Inc.) and to rescue valuable genetics from a herd ELISA positive for PRRSV and reestablish commercial use (C2, Midwest Producer). Genotype specific (GS) donor females (C1 n=40, C2 n=42) were synchronized for embryo recovery using Matrix® (Intervet, Millsboro, DE), 1250 IU PMSG (Sigma, St. Louis, MO) and 750 IU Chorulon® (Intervet, Millsboro, DE). Single-sire GS matings were made 34 hours after Chorulon® injection. Synchronous color specific (CS) supplemental embryos were produced in both cases to target 15 total embryos transferred for pregnancy support. Embryo recipients were synchronized with Matrix®, P.G. 600® (Intervet, Millsboro, DE) and Chorulon® for C1 and were natural cycle for C2. Embryos from GS and CS donors were surgically recovered on day 5 post insemination, washed per IETS requirements and transported in a portable incubator to the recipient herds. Embryos were surgically transferred within 6-14 hours after recovery into minus 24 (C1) and 12 (C2) hour asynchronous recipients. For C1, 587 (9.3±4.1, mean±SD) GS and 402 (6.4±3.0) CS embryos were transferred into 63 recipients for an average of 15.7±2.0/recipient. Fifty two (82.5%) recipients farrowed 429 live pigs (8.25±2.5/recipient), 231 GS (4.44±2.8) and 198 (3.81±2.4) CS. For C2, 665 (12.3±4.7) GS and 182 (3.4±3.7) CS embryos were transferred into 54 recipients for an average of 15.7±1.8/recipient. Thirty recipients (55.6%) farrowed a total of 248 live pigs (8.17±3.2/recipient), 182 (6.07±3.6) GS and 66 (2.10±2.6) CS. Day 5 embryos were successfully used to relocate swine genetics from a donor herd into a recipient herd with no observed health status change (C1) and to remove genetics from PRRSV to reestablish a healthy genetic supply source (C2).

**Key Words:** pig, embryo, embryo transfer

### 24 Basic studies in reproduction laid the foundation for genetic modification of swine: Where do we go next? R. S. Prather\*<sup>1,2</sup>, J. Zhao<sup>2</sup>, J. J. Whyte<sup>3</sup>, Y. Hao<sup>1</sup>, and C. N. Murphy<sup>1,2</sup>, <sup>1</sup>*Division of Animal Science, Columbia, MO*, <sup>2</sup>*National Swine Resource and Research Center, Columbia, MO*, <sup>3</sup>*University of Missouri, Columbia.*

Genetic modification of swine would not be possible without techniques to perform oocyte maturation, in vitro fertilization, embryo culture, estrous synchronization, embryo transfer, and induction of farrowing.

There are now two genes knocked out as well as over 30 transgenes in pigs. While many of these modifications are proving to be valuable for medicine, there is tremendous opportunity for production agriculture. While some genetic modifications have been made to improve meat quality, efficiency of production and decrease pollution in the pork industry, opportunities still abound. Many of these advances have been made without a fully sequenced genome. Completion and annotation of the swine genome will provide the tools necessary to quickly make additional genetic modifications. What genes should be modified? What evidence is there for candidate genes? What would you like to change: Decrease embryonic loss, Increase ovulation rate, Increase uterine capacity, Increase milk production, Improve the carcass composition, Increase heat tolerance, Improve feed efficiency, Create disease resistance, Reduce the environmental impact? There is still no genetically modified animal that has been approved to enter the food supply, so what genetic modification(s) would increase our understanding of production agriculture and permit a change in management with current genetics? To enhance public acceptance of genetically modified animals conditional gene modification methods based on site-specific recombination could, in theory, allow the removal of transgenes at the desired time, e.g. transgenic swine could overexpress growth hormone while growing and have the transgene excised prior to slaughter, effectively reverting the genotype to wild-type. Improvements to non-permanent methods of gene regulation (e.g. RNA interference) may also enhance the health and quality of swine, demonstrating a clear consumer advantage for these animals. The types of modifications that can be made to pigs are almost unlimited, and if genes to affect these traits are identified such modifications are in the sphere of possibility.

**Key Words:** transgene, knockout, swine

**25 Viral-mediated transduction of livestock physiology.** R. V. Anthony\*, J. D. Cantlon, S. H. Purcell, and C. M. Clay, *Colorado State University, Fort Collins.*

Transgenesis and gene ablation techniques applied to laboratory rodents have provided considerable insight into gene regulation and function. However, the interpretation of these studies can be impacted by the genetics of the inbred strains used, and the inherent physiological differences between laboratory rodents and large domestic animals or humans must also be factored into the translation of principles from one species to another. The use of similar methodologies in livestock species has yet to yield an efficient approach, although progress is being made through somatic cell nuclear cloning approaches. Viral-mediated transgenesis is one approach that can be used in livestock. Adenovirus- and lentivirus-derived vectors provide a high rate of infectivity in most mammalian cell types, with lentiviral vectors allowing stable integration into the host genome if the study of long-term effects is needed. We have used lentiviral-mediated transduction of sheep blastocysts, to obtain trophectoderm-specific expression of short-hairpin RNA (shRNA)

constructs. This in vivo approach to RNA interference has allowed us to examine the role of periattachment factor (PRR15), a nuclear coregulator of transcription that is expressed during conceptus development in a variety of species. By targeting the in vivo degradation of sheep PRR15 mRNA in conceptuses, we determined that PRR15 is required for continued conceptus growth and survival. This same approach could be used to determine the function of any gene expressed by placental trophoblast cells. We have also used adenoviral-mediated overexpression of follistatin in transgenic mice to demonstrate the divergent transcriptional regulation of the mouse and sheep gonadotropin releasing hormone receptor genes. While viral-mediated transgenesis may not be readily accepted as an approach to generate new production lines of livestock, it does provide robust experimental approaches to examine gene regulation and function in livestock. Supported by National Research Initiative Competitive Grant no. 2005-35203-15885 from the USDA Cooperative State Research, Education, and Extension Service, and by National Institutes of Health grant R01 HD43089.

**Key Words:** RNA interference, virus, blastocyst

**26 Utilization of genomic chip technology for improvement of reproduction in swine.** A. C. Clutter\*, *Newsham Choice Genetics, St Louis, MO.*

Each of the traits that define reproductive efficiency in swine (e.g., number of piglets born alive) is biologically complex and expressed through pathways regulated by multiple genes. Although only a subset of the genes in those pathways contain meaningful sequence variation, there are likely hundreds of genes contributing to the between- and within-line genetic variation in each important trait. Consequently, efforts to map the genomic loci contributing to genetic variance must be genome-wide and powerful enough to detect hundreds of genes, most with small or moderate effects. If such maps can be constructed with enough resolution to assure sustainable linkage disequilibrium between genetic markers and contributing genes, effective marker-assisted selection can begin before identification of the underlying gene(s). Since the traits defining reproductive efficiency are largely sex-limited and lowly heritable, the addition of marker-assistance to conventional selection could potentially add significant accuracy and genetic improvement. The resolution of the map is a function of the size of the population sample on which the traits are recorded and the number of genome-wide markers for which each animal is genotyped. Initial genome scans in maternal lines at Newsham Choice Genetics have been completed with marker density of approximately 6,000 genome-wide markers, and the resulting marker-trait associations implemented in marker-assisted selection. The extension to new chip arrays with approximately 50,000 genetic markers, and the integration of maps of genetic variance with data from expression-array chips will be discussed.

**Key Words:** genomics, selection, swine

## Breeding and Genetics

**27 Impact of gilts' body composition and body structure on reproductive performance.** M. Nikkilä\*<sup>1</sup>, K. Stalder<sup>1</sup>, B. Mote<sup>2</sup>, J. Lampe<sup>3</sup>, B. Thorn<sup>4</sup>, M. Rothschild<sup>1</sup>, A. Johnson<sup>1</sup>, L. Karriker<sup>1</sup>, and T. Serenius<sup>5</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Fast Genetics, Saskatchewan, Canada*, <sup>3</sup>*Swine Graphics Enterprises, Webster City, IA*, <sup>4</sup>*Newsham Choice Genetics, West Des Moines, IA*, <sup>5</sup>*FABA Breeding, Vantaa, Finland.*

The goal of this study was to estimate the genetic parameters for body composition, growth, body structure and reproductive traits. The study

involved 1447 commercial females from two genetic lines. They were progeny of 58 known sires and 835 dams. Gilts averaged 124±11 kg and 190±7 days age at evaluation. Body composition traits included ultrasonic last rib backfat, 10<sup>th</sup> rib backfat and loin muscle area. Standard formulas published by NPPC were applied to adjust 10<sup>th</sup> rib backfat, loin muscle area, and the number of days to 113.5 kg. Body structure (body length, depth and width, rib shape, top line and hip structure) was independently evaluated on a nine point scale by two experienced

scorers. Reproductive traits were cumulative total number born, number born alive and number weaned across three parities. AI-REML and the DMU-package were used to estimate variance components. The statistical model for growth and body composition traits included genetic line and evaluation day as fixed effects and animal as a random effect. Weight at evaluation was a linear covariate for last rib backfat. Body structure was analyzed with an identical model to last rib backfat, except scorer was included as an additional fixed effect. The model for reproductive traits had genetic line and herd entry group as fixed effects and animal as a random. Heritability estimates were high for growth and body composition traits ( $h^2=0.50-0.73$ ), low to moderate for body structure traits ( $h^2=0.11-0.34$ ) and low for reproductive traits ( $h^2=0.12$ ). Slower growth rate, greater backfat and larger loin muscle area were genetically associated with improved reproductive performance ( $r_g=0.07-0.48$ ). A favorable trend was observed between body structure and reproductive traits ( $r_g=-0.83-0.47$ ). Body length and rib shape had the most significant associations with reproduction; females with shorter body and more shaped ribs farrowed and weaned more piglets during the first three parities. Replacement gilt selection should target females with optimal body structure and sufficient body composition, as this would likely improve reproductive performance and hence the profitability for pork producers.

**Key Words:** gilt, body structure, reproduction

**28 Estimates of variance components and genetic correlations between swine estrus traits.** M. T. Knauer<sup>\*1</sup>, M. T. See<sup>1</sup>, J. P. Cassady<sup>1</sup>, and D. W. Newcom<sup>2</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Newsham Choice Genetics, West Des Moines, IA.

Variance components and genetic correlations were estimated between swine estrus traits in Landrace-Large White gilts, ( $n=1,225$ , GIS of NC) from 59 sires. Four groups of gilts entered the NC Swine Evaluation Station, Clayton, NC at an average age of 162 d and were checked daily for estrus. Once 70% of gilts reached puberty, recording of estrus symptoms occurred every 12 h for 30 d utilizing fence-line boar contact. Subjective estrus traits were visual vulva symptoms (vulvasizecolor), maximum strength of standing reflex with (estrusbehaviormax) and without a boar present (maxbacktest), and total strength of standing reflex with (totalestrusbehavior) and without boar (totalbacktest). Objective estrus traits consisted of vulva width, vulva Minolta colorimeter (vulvacolor), length of standing reflex (estruslength), and age at puberty. Growth and carcass traits included puberty weight (PUBWT), days to 114 kg (DAYS), real-time ultrasound 10th rib backfat and 10th rib loin eye area at 114 kg (BF, LEA) and puberty (PUBBF, PUBLEA). Variance components were estimated with MTDFREML using an animal model. All models included group and breed composition as fixed effects, on-test age as a covariate, and a random common litter effect. Models for vulva width, vulvacolor, PUBBF, and PUBLEA contained PUBWT as a covariate. Heritability estimates for vulvasizecolor, estrusbehaviormax, maxbacktest, totalestrusbehavior, totalbacktest, vulva width, vulvacolor, estruslength, age at puberty, PUBWT, DAYS, BF, LEA, PUBBF, PUBLEA, were 0.17, 0.20, 0.38, 0.32, 0.42, 0.22, 0.26, 0.28, 0.37, 0.52, 0.25, 0.51, 0.12, 0.42, and 0.20, respectfully. Common litter effect estimates for vulvasizecolor, vulva width, LEA, and PUBLEA, were 0.22, 0.25, 0.16, and 0.15, respectfully. Estimated genetic correlations between estruslength with estrusbehaviormax, maxbacktest, totalestrusbehavior, and totalbacktest ranged from 0.63 to 0.94. Estimated genetic correlations between age at puberty with estruslength, estrusbehaviormax, maxbacktest, totalestrusbehavior, and

totalbacktest ranged from -0.24 to -0.44. These results indicate sufficient genetic variation exists to select for swine estrus traits.

**Key Words:** estrus, heritability, pig

**29 Estimates of variance components and genetic correlations between swine structural conformation traits.** M. T. Knauer<sup>\*1</sup>, M. T. See<sup>1</sup>, J. P. Cassady<sup>1</sup>, and D. W. Newcom<sup>2</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Newsham Choice Genetics, West Des Moines, IA.

Variance components and genetic correlations were estimated between swine structural conformation traits. Data included 858 Landrace-Large White gilts (GIS of NC) from 51 sires. Gilts were visually scored at approximately 136 kg by two trained livestock evaluators. Subjective structural conformation scores included muscle mass (MUSCLE), rib width (RIB), front leg side view (FSIDEVIEW), rear leg side view (RSIDEVIEW), front view (FVIEW), rear view (RVIEW), and locomotion (LOC). Both MUSCLE and RIB were scored on five point scales with a score of five being heavier muscled and wider ribbed, respectively. The traits FSIDEVIEW, RSIDEVIEW, FVIEW, and RVIEW were scored on a seven point scale where four was optimal and a score of one was softer in the pasterns, sickle-hocked, splay-footed, and cow hocked, respectively. Locomotion was scored on a seven point scale where 1 was most favorable. Variance components were estimated with MTD-FREML using an animal model. All models contained gilt group, breed composition, and evaluator as fixed effects, on-test age as a covariate, and a random common litter effect. Heritability and phenotypic variance estimates for MUSCLE, RIB, FSIDEVIEW, RSIDEVIEW, FVIEW, RVIEW, and LOC were 0.50, 0.47, 0.58, 0.08, 0.11, 0.27, and 0.51 and 0.51, 0.90, 1.05, 0.67, 0.37, 0.32, and 1.02, respectively. Phenotypic and genetic correlation estimates between LOC with MUSCLE, RIB, FSIDEVIEW, RSIDEVIEW, FVIEW, and RVIEW were -0.12, -0.27, 0.57, 0.13, -0.19, and -0.23 and -0.15, -0.48, 0.78, 0.09, -0.94, and -0.51, respectively. These results indicate selection for locomotion will improve structural conformation especially for front leg structure.

**Key Words:** feet and leg soundness, gilt, heritability

**30 Longitudinal analysis of body weight and feed intake in selection lines for residual feed intake in pigs.** W. Cai<sup>\*</sup>, H. Wu, and J. C. M. Dekkers, Iowa State University, Ames.

A selection experiment for reducing residual feed intake (RFI) in Yorkshire pigs consists of a line selected for lower RFI (LRFI) and a random control line (CTRL). Previous generations used simple quadratic and linear regression on age on a pig-by-pig basis for daily feed intake (DFI) and bi-weekly body weight (BW), but these may not be optimal. The purposes of this study were to find the best linear mixed model to predict DFI and BW, and to evaluate the effect of selection for LRFI on BW and DFI curves. 64 LRFI and 87 CTRL boars from generation 5 with DFI and BW from ~3 to ~8 months of age were used. Forty linear mixed models with different order polynomials of age as fixed and random effects, and with homogeneous or heterogeneous residual variance by month of age, were fitted for both DFI and BW. Based on predicted residual sum of squares (PRESS) and residual diagnostics, cubic polynomial random regression was identified to be best, but with heterogeneous residual variance for DFI and homogeneous residual variance for BW. Compared to the original models, these decreased PRESS by 4% for DFI and by 42% for BW. Both Logistic and Gompertz non-linear models were also fitted. Since both gave similar results, only

Gompertz results will be reported. For DFI, LRFI pigs had slightly lower mature feed intake (2.93 vs. 2.96 kg) and an earlier inflection point (80 vs. 84 d) but differences were not significant ( $p > 0.1$ ). The LRFI line, however, had a significantly ( $p=0.06$ ) greater decay parameter (87 vs. 65 d). For BW, LRFI pigs had a significantly ( $p=0.02$ ) lower mature body weight (263 vs. 298 kg) and a significantly ( $p=0.07$ ) earlier inflection point (182 vs. 194 d). The decay parameter was lower for LRFI pigs (128 vs. 135 d) but not significant ( $p>0.1$ ). In conclusion, cubic polynomial regression significantly decreased prediction errors and LRFI selection has resulted in a lower feed intake curve toward maturity, lower mature body weight, and earlier inflection points for growth. This research was funded by the National Pork Board and the Iowa Pork Producers Association.

**Key Words:** residual feed intake, longitudinal analysis, pigs

**31 Growth and efficiency of pigs selected for residual feed intake on restricted and ad libitum diets.** N. Boddicker\*, N. Gabler, M. Spurlock, and J. C. M. Dekkers, *Iowa State University, Ames.*

Understanding feed efficiency is of major interest to the swine industry. To this end, a line of Yorkshire pigs selected for lower residual feed intake (LRFI) was developed. The objective of this study was to evaluate the 5th generation of the LRFI line against a randomly selected control line (CTRL) for protein and energy use and overall efficiency. Eighty barrows, 40 from each line, were paired by age (~132d) and weight (74.8±9.9 kg), and randomly assigned to 1 of 4 feeding treatments in 10 replicates: 1) ad libitum (adlib), 2) 75% of feed intake of adlib CTRL (75%), 3) 55% of ad lib (55%) and 4) weight maintenance (M), with weekly adjustments in intake to keep bodyweight constant for each pig. Pigs were individually penned (group housing was used for selection) and on dietary treatments for 6 weeks. Initial body weight did not differ between lines ( $p = .49$ ). The adlib LRFI pigs consumed 8% less feed than the CTRL ( $p = .15$ ), with no differences in daily gain. The 55% LRFI pigs gained 10% more ( $p = .008$ ) than the CTRL, while consuming the same amount of feed. For the 75% treatment, extra gain of the LRFI pigs was non-significant ( $p = .65$ ) at less than 2%. Although pigs on the M treatment were targeted to have no gain, LRFI pigs gained 81 g/d, compared to 13 g/d for the CTRL ( $p=0.11$ ). Despite this greater gain, the LRFI pigs had 11% lower feed intake than the CTRL ( $p = .051$ ). In conclusion, pigs selected for RFI under ad libitum feeding in group housing were also more efficient when penned individually and under restricted feeding. In particular, the LRFI pigs required less feed for static body weight, utilized feed more efficiently for growth when on a restricted diet, and required less feed for a similar amount of growth at ad libitum feed intake. Further analyses will focus on identifying physiological mechanisms and metabolic pathways that are responsible for the observed differences, with the ultimate goal of developing traits or markers for selection. This research was funded by grants from the National Pork Board and the Iowa Pork Producers Association.

**Key Words:** residual feed intake, restricted feeding, efficiency

**32 Identification of genetic markers associated with fatness and leg weakness traits in the pig.** B. Fan\*, S. K. Onteru, M. T. Nikkilä, K. J. Stalder, and M. F. Rothschild, *Iowa State University, Ames.*

Selection for production efficiency in the pork industry has resulted in some undesired side effects on reproduction, meat quality and locomotive issues. Leg weakness, described as poor leg conformation or a clinical syndrome characterized by anomalies of attitude and gait, and difficulty to rise or mount, is one of the major components contribut-

ing to locomotive problems. Average culling rates of 20–40% in sows because of feet and leg (FL) disorders have been reported. It has also been observed that leg weakness has increased over time with selection for leanness and the fatter animals tend to have better leg action and FL structure. Few genetic markers influencing both fatness and locomotive traits have been reported. Based on our recent large-scale association studies on body conformation and locomotive traits, a total of 35 SNPs from 31 genes were found to be significantly ( $P\leq 0.05$ ) or suggestively ( $P\leq 0.1$ ) associated with 10th rib back fat in a commercial population of 2,066 sows. Of these genes related to backfat, 29 SNPs have been identified to be associated with at least one FL trait and/or overall leg action. The genotyping and association analyses with fatness traits were also performed in the ISU Berkshire×Yorkshire pig resource family. Of 35 SNPs, 14 SNPs from 13 genes (COL11A2, GGT1, IL13, IGFBP5, LIF, MATN3, MC4R, MTHFR, PPAR $\gamma$ , SLC22A5, TNF $\alpha$ , VDBP and WARS2) exhibited significant ( $P\leq 0.05$ ) or suggestive ( $P\leq 0.1$ ) associations with fatness traits including average backfat, backfat at the lumbar, 10th rib and last rib. The alleles favorable for decreased back fat thickness tended to be associated with poorer leg action and FL structure, suggesting that these genes have pleiotropic effects on both fatness and FL soundness, and that they should be utilized in marker assisted selection with caution.

**Key Words:** fatness, leg weakness, association analyses

### 33 WITHDRAWN.

**34 Genetic parameters of heat stress tolerance in sows.** S. Bloemhof\*<sup>1,2</sup>, E. Knol<sup>1</sup>, and I. Misztal<sup>3</sup>, <sup>1</sup>*Institute for Pig Genetics, Beuningen, The Netherlands*, <sup>2</sup>*Animal Breeding and Genomics Centre, Wageningen, The Netherlands*, <sup>3</sup>*University of Georgia, Athens.*

Reproductive performance is of great importance in commercial pig breeding programs. Pig production occurs on farms all over the world including hot climates; in these hot climates a limiting factor for pig production is heat stress. Sows are exposed to heat stress when temperature exceeds 20C, the upper critical temperature of the sows thermo-neutral zone. High heat reduces reproductive performance of sows. Management factors such as cooling can improve performance of sows. An alternative is to select animals for increased heat tolerance, for which estimates of genetic components of heat tolerance are necessary. The advantage of increasing heat tolerance is that the changes in the genetic composition of the pig population are permanent. The objective of this study was to estimate genetic variation in heat tolerance expressed in reproductive performance traits.

Data included 62,232 observations on reproductive performance from 19,359 sows on 28 farms in Spain and Portugal collected from 2005 to 2007. Sows belonged to 2 different sow lines, a Yorkshire sow line and a Large White sow line. Two reproduction traits were analyzed: farrowing rate (0 or 1) and litter size (1 to 25). Insemination records were combined with the maximum outside temperature at day of insemination. Heat load was defined as (temperature - 20C) and was 0 when temperature was < 20C.

The linear animal model included the fixed effects of herd year month, parity, line, the random effects service sire and permanent environment and the additive animal effect. When heat load was present a random regression on heat load was added to the permanent environmental effect and to the additive animal effect. Variance components were estimated using REML.

For temperatures below 20C, heritability for farrowing rate was 0.02 and heritability for litter size was 0.07. When temperature increased to 35C (which corresponds to a heat load of 15) heritability increased to 0.03 for farrowing rate and to 0.10 for litter size. The additive variance for heat tolerance was then almost 35% of the general effect. These results clearly indicate possibilities for genetic selection on heat tolerance in reproductive performance.

**Key Words:** heat stress, sows, reproduction

**37 Correlation of pelvic measures in beef cows with calf birth weight and dystocia score.** J. M. Rumph<sup>\*1</sup>, R. E. Williams<sup>2</sup>, and J. K. Bertrand<sup>3</sup>, <sup>1</sup>Michigan State University, Lake City, <sup>2</sup>American-International Charolais Association, Kansas City, MO, <sup>3</sup>University of Georgia, Athens.

Records from 2306 Hereford calves measured at the University of Georgia Calhoun Research Facility were analyzed to determine the correlation between pelvic area of the dam and birth weight of the calf. Data included only single born bull (51%) and heifer (49%) calves and were analyzed using three separate multi-trait analyses. All analyses included dystocia score (DS) and calf birth weight (CBW). Analysis 1 also included pelvic height of the dam (PH) and pelvic width of the dam (PW), Analysis 2 included ratio of pelvic width to pelvic height of the dam (RA), and Analysis 3 included pelvic area of the dam (PA). Heritability estimates were 0.11 (0.03), 0.45 (0.04), 0.54 (0.04), 0.62 (0.04), 0.50 (0.04), and 0.50 (0.04) for DS, CBW, PH, PW, RA, and PA respectively. Direct genetic correlations with DS were 0.39 (0.11) and 0.15 (0.14) for CBW and RA, respectively. Direct genetic correlations with CBW were -0.17 (0.07), 0.21 (0.07), and -0.10 (0.07) for PH, RA, and PA, respectively. The direct genetic correlation for PH with PW was 0.57 (0.05). All other correlations were not significant. Selection for a smaller RA can be expected to decrease calving difficulty in beef operations while selection for larger PH or PA can be expected to decrease CBW, but has no effect on calving difficulty. Therefore, producers selecting animals based on pelvic measurements should make selection decisions based on the ratio of width to height rather than based on the individual measurements or area in order to decrease incidence of dystocia in the beef herd.

**Key Words:** birth weight, dystocia, pelvic measures

**38 Simulation of genomic selection in a crossbred beef cattle population.** K. Kizilkaya<sup>\*1,2</sup>, R. L. Fernando<sup>1</sup>, and D. Garrick<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Adnan Menderes University, Aydin, Turkey.

A simulation study was carried out to determine the likely accuracy of genomic prediction using the Illumina 50K SNP panel in a multibreed beef cattle population for a trait with heritability of 50% determined either by 50, 100, 250 or 500 QTL. After QTL were created by randomly selecting 50, 100, 250 and 500 SNPs from the 50K SNPs across chromosomes on about 1000 animals, their effects were sampled from a normal distribution. The breeding value of animal  $i$  was calculated as  $\sum_j g_{ij}\beta_j$  where  $g_{ij}$  is the genotype of animal  $i$  at QTL  $j$  and  $\beta_j$  is the effect of QTL  $j$ . Phenotypic values of animals for the four QTL cases with 5 reps were generated by adding residuals from a normal distribution to the breeding values of animals. An independent data set with same SNP loci and effects was used in validation. The simulated data analysis assumed  $y = \mathbf{1}\mu + \sum_k \mathbf{x}_k \beta_k \delta_k + \mathbf{e}$ , where  $y$  is the vector of trait phenotypes,  $\mu$  is the overall mean,  $\mathbf{x}$  is the column vector of the SNP genotypes at locus  $k$ ,  $\beta_k$  is the SNP effect,  $\delta_k$  is a 0/1 indicator variable and  $\mathbf{e}$  is the vector

of random residual effects. SNP effects were estimated by a Bayesian model averaging method similar to Bayes-B, except with a common variance for marker effects in the model. Three sets of SNP genotypes were used for genomic selection: only QTL genotypes (Set1), only the highest-LD markers for each QTL (Set2), and all 50K markers, excluding the QTL (Set3). Correlations between true and estimated genotypic values of animals for the validation data set were calculated. Correlations (0.918 to 0.663) from Set1 were high but decreased as number of QTL increased, indicating that genotypic value can be predicted successfully by using true QTL in a data set having sufficient observations. However, correlations were low (0.199 to 0.108) for Set3 revealing that LD was not sufficient for genomic selection in this crossbred population. Set5 gave results similar to those from model 3, indicated that the Bayesian approach was able to capture the information from the markers in LD with the QTL.

**Key Words:** SNP genotype, genomic selection, Bayes-B

**39 Gut microbial population differently affects feed intake in mice lines selected for high and low heat loss.** M. Nielsen<sup>\*</sup>, R. Griess, J. Walter, and A. Benson, *University of Nebraska, Lincoln*.

Lines of mice differing greatly in feed intake and efficiency were given a cocktail of antibiotics to evaluate whether variation in gut microbial population might contribute to variation in feed intake. Lines of mice were developed through selection for high (MH) or low heat loss (ML), as well as an unselected control (MC) in 3 replications (R) (total of 9 lines). Selection was for a total of 25 generations (G) (G0-16 and G42-51). Mice in this study came from G58 (R1 and 2) and 59 (R3). Adult male mice (16 to 18 wk at start;  $n = 8/\text{line}$  in R1 and 2, and  $n = 10/\text{line}$  in R3) were individually caged with feed intake measured 4 wk before antibiotic treatment, 4 wk on treatment, and 4 wk post treatment. The last 3 wk of feed intake in each phase (pre-treatment, treatment and post-treatment) were the data subjected to statistical analysis. Orthogonal contrasts were used to test the effect of selection (MH  $\times$  ML) and asymmetry of selection response ( $[\text{MH} + \text{ML}]/2 \times \text{MC}$ ). During treatment, animals received drinking water as a cocktail of streptomycin (2 g/L), metranidazole (0.6 g/L) and neomycin (0.35 g/L); animals received standard tap water during pre- and post-treatment periods. There was no selection effect ( $P = 0.74$ ) for body weight, but there was a large selection effect in pre-treatment feed intake ( $P < 0.01$ ; MH/ML = 1.34), a smaller selection effect on feed intake during treatment ( $P > 0.08$ ; MH/ML = 1.18), and again a large selection effect on post-treatment feed intake ( $P < 0.01$ ; MH/ML = 1.30). During treatment, MH mice intake decreased slightly (0.98) compared to pre-treatment level of intake, but ML mice increased greatly (1.10) over their pre-treatment level; effect of selection was thus evident ( $P = 0.02$ ). Our findings indicate that the gut microbiota differently affect feed intake and efficiency in mice selected for high and low heat loss. It is therefore likely that selection resulted in the development of distinct gut microbial populations which affect host feed intake differently.

**Key Words:** mice, feed intake, gut microbial population

**40 Predicting allele frequencies in a DNA pools using Illumina high density SNP genotyping data.** B. L. Peiris<sup>\*1</sup>, J. Ralph<sup>2</sup>, S. J. Lamont<sup>1</sup>, and J. C. M. Dekkers<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Aviagen Ltd. UK, UK.

Recent scientific and technological advances have made genotyping large numbers of individuals for large numbers of SNPs across the genome possible. Although declining, costs per sample are still pro-

hibitive for many applications. One way to reduce costs is to use pools of DNA from multiple individuals, e.g. for case-control or selective genotyping studies. This, however, requires methods to estimate allele frequencies in pools. To evaluate the ability to use DNA pools using the Illumina Infinium genotyping assay, two sets of gradient pools were created using two combinations of Iowa State University highly inbred chicken lines. Pools containing 0, 10, 20, 40, 60, 80, 90, and 100% of line A vs. B or line C vs. D were created. Two replicate pools were prepared for each gradient, except for the 0 and 100% pools, resulting in 28 pools. All pools were genotyped for 12,046 SNPs using the Illumina Infinium assay. After removing SNPs that were fixed for the combination of two lines, 3,321 and 3,618 SNPs were used for analysis in the AxB and CxD pools. Normalized intensities were provided by Illumina for each pool and each SNP. Two methods proposed in literature to convert normalized intensities to estimates of allele frequencies were compared to three alternate methods proposed herein based on MSE, bias, and variance of estimated versus true allele frequencies and based on the fit of a simple linear regression of estimated on true frequencies. The three new methods had average square root MSE of 6.9, 6.9 and 7%, compared to 7.6 and 7.7% for the two literature methods. Average biases were slightly greater for the three new methods 1.78, 1.79 and 1.81%, compared to 1.66 and 1.70% for the two literature methods, but the SD of estimates were substantially smaller for the new methods 5.69, 5.72 and 5.73%, compared to 6.02 and 6.67% for the literature methods. In conclusion, intensity data from the Illumina Infinium Assay can be used to estimate allele frequencies in pools, allowing for substantial savings in genotyping costs for specific applications. Methods for estimation of allele frequencies were developed that outperformed those available in literature.

**Key Words:** DNA pools, SNP

**41 Bivariate Student-t error linear mixed model and Bayesian MCMC implementation.** K. Kizilkaya\*<sup>1,2</sup> and B. Mestav<sup>2</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Adnan Menderes University, Aydin, Turkey.

A simulation study was used to validate bivariate Student-t model and the utility of Deviance Information Criterion (DIC) for model choice between bivariate normal (BN) model and bivariate Student-t (BT) model. Two replicated datasets were generated from each of three different populations as characterized by the residual degrees of freedom (df=4, df=12 and df=∞). A BT error linear mixed effect model was used to generate phenotypes of 50 progeny from each of 50 unrelated sires for two traits. As a positive control, the data for each replicate was analyzed using both BN and BT error linear mixed effects models. Graphical inspection of the chains based on preliminary analyses was used to determine a common length of burn-in period. For each replicated data set within each population, a burn-in period of 5000 cycles was seen to be sufficiently large upon which random draws from each of an additional 20000 MCMC cycles were subsequently saved. Furthermore, DIC value was computed for each model on each replicated dataset to validate those measures as model choice criteria. In all cases, flat unbounded priors were invoked on the variance components and on the fixed effects and the vaguely informative prior was used for df. Inference on df (4.63 and 3.75) was surprisingly sharp and seemingly unbiased for the BT error linear mixed effects model analysis of bivariate data from Population I (df=4), with 95% equal-tailed posterior probability interval (PPI) not exceeding 1.5 in width. Inference on df from Population III (df=∞) indicated extremely wide 95% PPI and posterior means (245 and 310) exceeding 100, indicating strong evidence of BN error model versus BT error model for bivariate data from that population. In the analyses of bivariate data from replicated datasets from three

populations, the 95% PPIs were in good agreement with true values of sire and herd variance-covariance matrices. The model choice based on DIC for the bivariate Student-t linear mixed effects model analyses of data were always resounding in the favor of the correct model within each population.

**Key Words:** bivariate student-t, robust linear model, MCMC

## 42 WITHDRAWN.

**43 Ultrasonically measured ribeye area in beef cattle: A look into the relationship between image quality and prediction bias.** M. L. Spangler\*<sup>1</sup>, S. P. Greiner<sup>2</sup>, T. D. Pringle<sup>3</sup>, J. M. Rumph<sup>4</sup>, D. R. Strohbahn<sup>5</sup>, and W. D. Busby<sup>5</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Virginia Polytechnical Institute and State University, Blacksburg, <sup>3</sup>University of Georgia, Athens, <sup>4</sup>Michigan State University, East Lansing, <sup>5</sup>Iowa State University, Ames.

Ultrasonic measurements (n=4,034) for predicted ribeye area (UREA) and their associated image quality scores (IQ) obtained from the Ultrasound Guidelines Council (UGC) certification held in Ames, Iowa from 2005-2008 were utilized to quantify the relationship between IQ and the absolute value of prediction bias (ABS) calculated as the difference between UREA and carcass ribeye area (CREA). Currently, IQ are utilized as a subjective criterion to partially determine the proficiency of an ultrasound technician. IQ represents a 1-7 scale where those images classified as a 1 or 2 are acceptable, 3-5 are marginal, and images scored as a 6 or 7 are rejected and not interpreted in practice. The frequency of IQ were 3.4, 40.51, 25.01, 18.91, 10.04, 2.03, and 0.10% for IQ of 1, 2, 3, 4, 5, 6, and 7, respectively. Unadjusted means (SD) for ABS were 6.6(5.2), 6.7(5.6), 7.3(6.1), 7.0(5.7), 8.1(5.9), 9.2(6.6), and 12.7cm<sup>2</sup>(6.6cm<sup>2</sup>) for IQ of 1, 2, 3, 4, 5, 6, and 7, respectively. Due to the sparse frequency of data in extreme categories, IQ categories were changed such that scores of 1-2, 3-5, and 6-7 were merged. The GLM procedure of SAS was used to predict ABS with explanatory variables of interpreting technician, IQ, and animal nested within year. IQ was not statistically significant (p=0.45) in the model that explained 44.5% of the variation in ABS. The results from the current investigation suggest that the subjective measure of IQ is not strongly related to ABS, particularly for images scored as a 1-5. More data, including measurements from additional UGC certifications, is needed to validate results presented here and to investigate the relationship between IQ and ABS from those images currently rejected particularly those with an IQ of 6.

**Key Words:** beef cattle, ultrasound, image quality

**44 Factors associated with feed intake of Angus steers.** M. G. Dib\*<sup>1</sup>, J. F. Taylor<sup>2</sup>, R. D. Schnabel<sup>2</sup>, and L. D. Van Vleck<sup>1,3</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>University of Missouri, Columbia, <sup>3</sup>Agriculture Research Service - USDA, Lincoln, NE.

Estimates of variance components were obtained from 475 records of average (AFI) and residual feed intake (RFI). Covariates in various (8) models included average daily gain (G), age (A) and weight (W) on test, and slaughter (S) and ultra sound (U) carcass measures (fat thickness, rib eye area and marbling score or intramuscular fat). All models included contemporary group (days on feed – pen – year). For AFI, choice of model affected estimates of genetic and residual variances and heritability. Heritability was largest (0.55) for model with A, W, and G. Other models resulted in similar heritability estimates

(0.31-0.37) although components of variance varied (genetic: 0.10-0.23; residual; 0.20-0.50). Models including either S or U in addition to A and W resulted in similar estimates of parameters. For RFI (AFI adjusted for ADG and metabolic body weight), models with only A and W as covariates and with no covariates resulted in near null estimates of parameters. The largest estimate of heritability was with A, W, and G as covariates (0.61). Estimates of heritability were greater with covariates for slaughter as compared with ultra sound carcass measures (0.41 and 0.42 vs. 0.34 and 0.35). With the exception of the two sets of near null estimates for RFI, estimates of phenotypic variances were similar for AFI and RFI. Although heritability estimates (and accuracy of EBV) for AFI are similar with or without adjustment to constant carcass measures, standard errors of prediction with adjustment for carcass measures would be smaller because of smaller genetic variance.

**Key Words:** Angus, feed intake, heritability

**45 Evaluation of G × E in Angus cattle by using reaction norms.** B. Maricle<sup>\*1</sup>, M. Kaps<sup>2</sup>, R. Weaber<sup>1</sup>, and W. Lamberson<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>University of Zagreb, Zagreb, Croatia.

Animal performance varies due to the influence of genotype by environment interaction (G×E). The purpose of this study was to determine the magnitude of G×E by fitting reaction norms in models for estimating heritabilities of growth traits in U.S. Angus cattle. Weights at birth (BW), 205 d (WW), and 365 d (YW) were adjusted according to American Angus Association guidelines. Environments were defined as progeny

groups from a common herd. For data to be included, the following criteria had to be met: each bull must have had at least 100 progeny, with at least six progeny per environment, in at least five environments per bull, and at least six bulls having progeny in each environment. The mean performance of all progeny within each herd environment was defined as the environmental mean. Mean performance of progeny of a sire within an environment was defined as the progeny mean. Four statistical models were evaluated for estimation of heritabilities. All models included year–season, contemporary group (processing date and lot id), and sex as fixed effects. Herd environment was fitted as a categorical effect in models designated CM and GEM. Environmental means were fitted as a continuous effect in models designated CEM and RRM. Models CM and CEM included sire as a random variable. Model GEM included sire and sire x herd environment interaction as random variables. Model RRM included reaction norms of each bull calculated by regressing progeny means on environment means. Regression coefficients from RRM were fitted to an ANOVA model including bull and environmental mean. Model fit statistics indicated RRM had the best fit. Heritability estimates ranged from 0.293 to 0.401 for BW; 0.141 to 0.289 for WW; and 0.147 to 0.259 for YW across all models. Regression coefficients differed among bulls for all traits (P< 0.0001). Rank correlations between environments depicted re-ranking of bulls. These results suggest that bulls differ in the consistency of their progeny's performance across environments. Estimates of genetic merit of regressions from reaction norms may be a useful selection tool for ranking bulls to be used across diverse environments.

**Key Words:** beef cattle, G×E, reaction norm

## David H. Baker Amino Acid Symposium

**46 Where is the next generation?** R. A. Easter<sup>\*</sup>, University of Illinois, Urbana.

This presentation is concerned with human resource needs in the field of nonruminant nutrition, which is defined as the branch of scholarship concerned with the practice of feeding animals in this category. Individuals in this field conduct research, teach and apply knowledge through professional employment. Practitioners are required to integrate knowledge from a disparate array of disciplines including biochemistry, ethology, physiology, cereal science and feed manufacturing technology. Academic programs in nonruminant nutrition are declining in number concomitant with waning student interest. Yet, the need for scholarship and well-prepared professionals in the field continues. If this trend is to be reversed, student interest in science and in particular the applied, integrative animal sciences must be encouraged at the elementary, secondary and collegiate levels. At the same time it will be essential that those who employ nonruminant nutritionists effectively communicate the need for high-quality baccalaureate, masters and doctoral graduates to decision makers in government and the university community.

**Key Words:** education, nonruminant nutrition

**47 The origin of methyl groups and their function.** J. T. Brosnan<sup>\*</sup>, Memorial University of Newfoundland, St. Johns, Newfoundland, Canada.

S-Adenosylmethionine (SAM) is a critical cellular molecule responsible for providing methyl groups for a large number of key reactions. These include the methylation of DNA and protein, and the synthesis of such

small molecules as creatine, phosphatidylcholine and epinephrine. When SAM donates its methyl group S-Adenosylhomocysteine (SAH) is formed. SAH is the only known source of homocysteine, a molecule which, at elevated levels, is linked to increased incidence of cardiovascular disease and dementia. Maintenance of cellular SAM levels requires both the provision of appropriately methylated compounds (methionine, choline, betaine, S-methylmethionine) and the endogenous production of methyl groups (methylneogenesis) via a folate- and Vitamin B12-dependent pathway. The balance between these two means of providing the methyl group of SAM is finely regulated. Quantitative considerations reveal that the synthesis of creatine and of phosphatidylcholine account for approximately two thirds of all methyl group utilization in adult humans. These processes are also important determinants of circulating homocysteine levels. Most of the body's creatine is found in muscle. We calculate that, because of the rapid expansion of their muscle mass, creatine synthesis accounts for approximately 70% of methyl group utilization in neonatal piglets. In addition to the requirement for SAM-derived methyl groups, creatine synthesis also requires arginine and glycine. This imposes a significant burden on arginine metabolism. (Supported by Canadian Institutes for Health Research)

**48 Whole-body growth, carcass growth and primal mass as indices of lysine adequacy in high lean growth pigs.** M. E. Johnston<sup>1</sup>, R. D. Boyd<sup>\*1</sup>, B. Fields<sup>3</sup>, C. Booher<sup>3</sup>, C. E. Fralick<sup>2</sup>, C. E. Zier-Rush<sup>1</sup>, and A. A. Sosnicki<sup>3</sup>, <sup>1</sup>The Hanor Company, Franklin, KY, <sup>2</sup>Swine Tek Research, Van Wert, OH, <sup>3</sup>PIC USA, Hendersonville, TN.

This experiment was conducted to determine if the lysine level that is required to maximize whole-body (WB) growth is comparable to that

needed for carcass growth and primal mass. Second, to determine if the metabolism modifier ractopamine (PLN) improved primal mass and (or) primal distribution. 320 PIC Camborough × TR-4 castrates were used in a growth assay from 22.9 kg ( $\pm$  .9 kg) to 131.5 ( $\pm$  1.4 kg) in pens of 10/pen. Pigs were blocked by weight and randomly allotted to diet regimens (8 pens/diet). Treatments consisted of 4 diet treatments, administered in 5 phases. Three involved feeding to different lysine curves (88, 100, 112% PIC specification). The fourth treatment involved feeding PLN to pigs having received the standard diet (100%) until 28 d pre-slaughter. PLN was provided at 7.2 ppm (14 d, 1.05% SID Lysine) followed by 8.8 ppm (15 to 28 d, 0.95% SID Lysine). The assay was time constant (105 d). WB ADG averaged  $1.035 \pm 0.015$  kg/d ( $P=0.154$ ) for the Lysine curves (88, 100, 112% Lysine specification). However, carcass yield declined linearly ( $P<0.05$ ; 76.5, 76.2, 74.4%) as specification increased. Thus, carcass ADG tended to decline (0.796, 0.775, 0.778 kg/d) and total carcass weight declined ( $P<0.02$ ) as Lysine increased. WB G:F ratio improved ( $P<0.005$ ) in a linear manner (0.422, 0.431, 0.439) with increasing Lysine. PLN improved ( $P<0.001$ ) WB ADG (1.218 kg/d) and WB G:F ratio (0.398), during the final 28 d period, when compared to the 100% counterpart (1.059, 0.341). FOM Lean was improved with PLN ( $P<0.001$ , 54.9% vs 52.7). Carcasses were cut into primal and sub-primal parts and related to a constant carcass end-weight (99.5 kg). Total primal weight did not differ for Lysine curves (avg. 79.1 kg/carcass), but PLN treatment improved primal weight (81.4 kg,  $P<0.15$ ) and primal percent of carcass (81.7 vs 79.4%). We conclude that a Lysine specification that is based only on WB growth may conflict with carcass growth, because yield is adversely affected by a high level. PLN increased the total primal and sub-primal mass by more than 2 kg.

**Key Words:** growth, amino acids, ractopamine

**49 Regulation of gastrointestinal function: Motivation from the distal gut.** K. A. Tappenden\*, *University of Illinois, Urbana.*

The regulation of intestinal structure and function is stimulated by nutrients within the intestinal lumen, however the exact mechanism is not known. When adult rodents are fed intravenously, with total parenteral nutrition (TPN), supplementation with a mixture of short-chain fatty acids (SCFA) enhances intestinal adaptation. However, the ability and timing of SCFA to augment adaptation in the neonatal intestine is unknown. Furthermore, the specific SCFA inducing the intestinotrophic effects and underlying regulatory mechanism(s) are unclear. Therefore, we examined the effect of SCFA supplemented TPN on intestinal adaptation and hypothesized that butyrate is the responsible SCFA. Piglets ( $n=120$ ) were randomized to: 1) control TPN, or TPN supplemented with; 2) 60 mM SCFA (36 mM acetate, 15 mM propionate and 9 mM butyrate); 3) 9 mM butyrate, or; 4) 60 mM butyrate. Within each group, piglets were further randomized to examine acute (4h, 12h, 24h) and chronic (3d or 7d) adaptations. Indices of intestinal adaptation, including crypt-villus architecture, proliferation and apoptosis, and concentration of the intestinotrophic peptide, glucagon-like peptide-2 (GLP-2), were measured. Villus height was increased ( $P < 0.029$ ) within 4 h by supplemented TPN treatments. Supplemented TPN treatments increased ( $P < 0.037$ ) proliferating cell nuclear antigen expression along the entire intestine. Indicative of an anti-apoptotic profile, jejunal Bax:Bcl-w abundance was decreased ( $P = 0.033$ ) by both butyrate supplemented TPN treatments, and ileal abundance was decreased ( $P = 0.0002$ ) by all supplemented TPN treatments, regardless of time. Supplemented TPN treatments increased ( $P = 0.016$ ) plasma GLP-2 concentration at all time points. GLP-2 may mediate the intestinotrophic effects of butyrate; however, this interaction requires additional research to determine an obligatory mechanistic relationship. Ultimately, this research will provide important

insight into the regulation of intestinal structure and function and has implications for both animal production and human health.

**50 The standardized ileal digestible isoleucine to lysine requirement ratio may not be greater than 50% in post-weaned piglets.** J. van Milgen\*<sup>1,2</sup>, R. Barea<sup>1,2</sup>, L. Brossard<sup>1,2</sup>, N. Le Floc<sup>3</sup>, D. Melchior<sup>3</sup>, and Y. Primot<sup>3</sup>, <sup>1</sup>INRA, UMR1079, Saint-Gilles, France, <sup>2</sup>Agrocampus Ouest, UMR1079, Rennes, France, <sup>3</sup>AJINOMOTO EUROLYSINE S.A.S., Paris, France.

The branched-chain amino acids (BCAA) Ile and Val are potentially limiting amino acids for growth in pigs. Although reports exist concerning the Ile requirement, results seem to vary with the BCAA content of the diet. The purpose of this study was to determine the response of piglets to L-Ile supplementation under different dietary conditions. Four experiments were performed that started at 5 wk of age and lasted for 3 wk using individually-housed piglets. Unless indicated otherwise, diets were based on cereals and soybean meal and contained 1.0% standardized ileal digestible (SID) Lys. In Exp. 1, 4 diets were used in a 2x2 factorial design providing 50 or 60% SID Ile:Lys in combination with 57 or 70% SID Val:Lys. The Ile content of the diet did not affect performance. The ADFI and ADG were respectively 15 and 20% lower in piglets receiving diets with 57% SID Val:Lys compared with those receiving 70% SID Val:Lys. In Exp. 2, a control diet was formulated to provide 48% SID Ile:Lys. Four other diets were formulated by supplementing the basal diet with 1 of 2 sources of L-Ile differing in degree of purity to obtain 52 and 56% SID Ile:Lys in the diet. Level and source of L-Ile supplementation did not affect performance. To exclude a possible interaction between Ile and Lys, 4 diets were used in Exp. 3 in a 2x2 factorial design providing 1.00 or 1.15% SID Lys combined with 48 or 60% SID Ile:Lys. The ADG and F:G were affected by Lys supply (8 and 6% higher for piglets receiving 1.15% SID Lys) but not by Ile supply. Experiment 4 was carried out to test the effect of L-Ile supplementation using diets differing in BCAA content. Two protein sources (spray-dried blood cells and corn gluten meal) and 2 levels of Ile were used (50 and 65% SID Ile:Lys) in a 2x2 factorial arrangement. The SID Val:Lys and Leu:Lys contents were respectively 105 and 167% for diets containing spray-dried blood cells, and 70 and 180% for the diets containing corn gluten meal. Neither protein source nor Ile level affected performance in piglets. These studies indicated that the SID Ile:Lys requirement may not be greater than 50% in cereal-based diets.

**Key Words:** pigs, isoleucine, requirement

**51 The evaluation of feeding lactating sows on grams of lysine compared to percent of lysine in the diet.** L. Greiner\*<sup>1</sup>, J. Soto<sup>1</sup>, J. Connor<sup>1</sup>, G. Allee<sup>2</sup>, J. Usry<sup>3</sup>, and N. Williams<sup>4</sup>, <sup>1</sup>Innovative Swine Solutions, LLC, Carthage, IL, <sup>2</sup>University of Missouri, Columbia, <sup>3</sup>Ajinomoto Heartland LLC, Chicago, IL, <sup>4</sup>PIC, Hendersonville, TN.

Two experiments were conducted with 328 and 200 multiparous sows (parity 4 and older, PIC Camborough 29,  $264.8 \pm 32.2$  kg) to determine which method of diet formulation was better in meeting the needs of the older lactating sow. In the first experiment, 328 sows were randomly allotted to free access to one of five lactation diets containing .85, .95, 1.05, 1.15 or 1.25% total lysine, respectively, throughout an  $18.8 \pm 2$  days lactation period. In the second experiment, sows were fed diets containing 6.4, 7.31, 8.22, 9.12 and 10.3 g of lysine/kg of feed. All diets were formulated to be isocaloric 3.46 Mcal ME/kg and exceeded recommendations (NRC, 1998). Litter numbers were standardized within 48 h after farrowing. Sows were fed with a computerized feeding system

that assured true ad libitum feed intake at 72 hours post-farrow for study one and a limited amount of feed not to exceed 5.5 kg/day for study two. In the first experiment, sow ADFI averaged 7 kg per day. Sow body weight gain was significantly reduced (20.8, 15.7, 17.8, 17.5, 10.4 kg,  $P \leq .04$ ) as lysine intake increased. However, subsequent performance and average daily pig gain were not significantly different ( $P \geq .1$ ). In the second experiment, total lysine intake was 35.2, 40.2, 45.1, 50.2, and 56.7 g of lysine per day, respectively. Sow weight gain was not affected by lysine intake. Piglet litter gain was linearly improved (2.18, 2.19, 2.25, 2.35, and 2.43 kg,  $P \leq .03$ ) with the feeding of additional lysine. In addition, piglet average daily gain was linearly improved as g of lysine increased (.228, .246, .239, .244, and .254,  $P \leq .03$ ). In conclusion, the feeding of a minimum of 50 g of lysine per day for older parity sows can improve piglet performance. In addition, formulating a sow diet based on percent lysine is only effective when total feed intake is known. Since total feed intake can vary within a herd, it is better to formulate the sow's requirements based on grams of lysine per day.

**Key Words:** lysine, sow, lactation

**52 Practical and theoretical evaluations of amino acid-related research for use in commercial swine production.** M. Edmonds\*, *Kent Feeds, Inc., Muscatine, IA.*

A model, which involved space allocation, was used to lower feed intakes in grow-finish pigs in order to determine the effect of various CP levels on performance. The data suggest that pigs with lower feed intakes as

a result of space restrictions do not have higher CP requirements than those with more space. Studies were conducted to evaluate compensatory growth as a potential feeding strategy to enhance lean meat production. Finishing pigs that were fed extreme CP variations had faster gains when uncrowded, but slower gains when crowded compared to finishing pigs fed constant levels of CP. Repetitive 2-wk regimens of protein overfeeding followed by underfeeding over a 12-wk period did not decrease gain per unit of CP intake. Further studies involving fluctuating CP levels with ractopamine (Paylean®, Elanco Animal Health) were evaluated in late finishing pigs. Despite wide dietary CP fluctuations, performance, gain: CP intake, and carcass traits were similar compared to pigs on the control regimen. These data suggest that pigs can exhibit compensatory responses to varying CP levels and can perform as well as pigs fed diets with more constant levels of CP. Several trials involving synthetic amino acids and intact proteins (corn and soybean meal) were conducted in growing-finishing pigs. Supplementing up to six amino acids to diets lower in CP did not result in similar performance and economics to the standard higher CP diet. Moreover, diets with lower levels of synthetic lysine with higher CP resulted in improved gain:feed ratios ( $P \leq .07$ ) compared to diets lower in CP with higher levels of synthetic lysine. In sow research, several synthetic amino acids (besides lysine) were added to a lactation diet to determine their effect on stillborn pigs. Diets were fed starting on Day 108 of gestation. Including synthetic amino acids in the diet increased ( $P \leq .05$ ) the number of stillborn pigs per litter. The data in growing-finishing pigs and sows suggest that synthetic amino acids need to be used in a judicious manner in swine production systems.

**Key Words:** compensatory growth, pigs, amino acids

## Extension Beef/Small Ruminant

**53 Time of day of harvest impact on nitrate concentration in forage sorghum.** R. C. LeValley, G. E. Selk\*, G. A. Highfill, H. Zhang, and C. J. Richards, *Oklahoma Cooperative Extension Service, Stillwater, OK.*

Forage sorghums are used by cattle producers for summer grazing or harvested for hay. Forage sorghums can be very productive and high quality, but can also accumulate toxic levels of nitrate when stressed. Based on the assumption that the plant continues soil nitrate uptake during overnight hours, followed by accelerated conversion of the nitrate to protein during daylight hours, extension recommendations have been to wait until afternoon to cut forage sorghum for hay if anticipated nitrate levels are marginally high. To evaluate the significance of the change in nitrate concentration in forage sorghums during the day, samples were collected at two hour intervals from 0800 to 1800. Samples were taken at 0800, 1000, 1200, 1400, 1600, and 1800. Five cooperators fields (farm) were divided into quadrants. Three random samples, consisting of ten stems each, were taken from each quadrant at the specified interval. The samples were analyzed at the Oklahoma State University Soil, Water, and Forage Analytical Laboratory to determine the level of nitrates ( $\text{NO}_3$ ; ppm). Nitrate was determined using an acetic acid extraction with cadmium reduction analysis. Results were analyzed using SAS analysis of variance, with time of day, farm, and interactions as the potential sources of the variation in nitrate concentration and proportion of samples that were greater than 10000 ppm  $\text{NO}_3$  (potentially lethal). As expected, farm was a significant source of variation for both mean nitrate concentration and percentage of samples greater than 10000 ppm. There was no significant time of day, or time of day x farm interaction for mean nitrate concentrations ( $P = 0.19$  and  $P = 0.71$ ,

respectively) or proportion of samples potentially lethal ( $P = 0.76$  and  $P = 0.99$ , respectively). The mean nitrate concentrations only varied from 3857 ppm at 0800 to 4962 ppm at 1200. Time of day of harvest did not impact nitrate concentration or proportion of potentially lethal samples of forage sorghum hay.

**Key Words:** nitrate, time of day, forage sorghum

**54 Effect of growing beef replacement heifers on wheat pasture before and during breeding on reproductive performance.** M. H. Bryant\*, G. E. Selk, R. P. Wettemann, D. L. Lalman, and G. W. Horn, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Unsatisfactory breeding performance has been reported when replacement heifers have been exposed to bulls or AI while grazing wheat forages. The objective of this study was to compare reproductive performance of heifers grazing wheat pasture before and during breeding with heifers grazing wheat pasture until approximately 3 weeks before breeding. In each of two years, 40 spring born Angus and Angus cross-bred heifers were placed on wheat pasture in December and randomly assigned to one of two treatment groups in mid March. Group one (WP;  $n=20$ ) remained on wheat pasture (mean CP 26.6 %) through estrus synchronization and fixed-time AI (FAI). Group two (DL;  $n=20$ ) was placed in drylot and had free choice access to a corn-based growing ration (11.1% CP) through estrus synchronization and FAI. Heifers were exposed to fertile bulls 10 d after FAI for 45 d. FAI conception was determined at 32 d post-AI by ultrasonography. Five weekly blood samples starting 5 wks before FAI were obtained to describe luteal activity prior to estrus synchronization and for analysis of blood urea-N

concentrations (BUN) before and during estrus synchronization and FAI. Reproductive data were analyzed by Chi-square. Concentrations of BUN were analyzed with the mixed model procedure of SAS with year as a random variable. The percentage of heifers with luteal activity was 75% and 55% for WP and DL, respectively ( $P = 0.06$ ). Weights of DL heifers were heavier than WP heifers ( $408$  vs.  $394$  kg  $\pm$   $9.89$ ) at the time of AI ( $P < 0.01$ ) but were similar ( $P = 0.43$ ) at ultrasound ( $417$  vs.  $414$  kg  $\pm$   $11.60$ ). Conception rate to FAI was similar ( $P = 0.31$ ) for WP (54%) and DL (43%) and final pregnancy rate was similar ( $P = 0.08$ ) for WP (98%) and DL (88%). Concentrations of BUN were less ( $P < 0.01$ ) for DL heifers during all weeks after treatments were imposed. Reproductive performance of heifers grazing wheat pasture during estrus synchronization and FAI was similar to heifers consuming a corn-based growing diet.

**Key Words:** beef replacement heifers, wheat pasture, reproduction

### 55 Profit variability for calf-fed and yearling production systems.

R. M. Small\*<sup>1</sup>, D. R. Mark<sup>1</sup>, D. M. Feuz<sup>2</sup>, and T. J. Klopfenstein<sup>1</sup>, <sup>1</sup>*University of Nebraska, Lincoln*, <sup>2</sup>*Utah State University, Logan*.

Twelve years of beef production data (1995-2007) from the University of Nebraska were used to create calf-fed and yearling production system budgets and to identify the year-to-year variability in profitability between the two systems. Calf-fed systems represented steers ( $N = 926$ ) that entered the feedlot after fall weaning ( $BW = 293 \pm 16.5$  kg) and were marketed the following spring. Yearling systems were comprised of steers ( $N = 437$ ) weighing an average of  $238 \pm 10.6$  kg after weaning. Yearlings were backgrounded on cornstalks and summer pasture before entering the feedlot the following fall and were marketed in December. Cattle were marketed on a grid basis, and rations were standardized in order to compare the cost variability of ration ingredients for the years evaluated. An economic enterprise budget model was used to estimate profits, and budget parameters were based on pen averages and actual market prices. On average, the two beef production systems reported profits that were not statistically different ( $P < 0.90$ ) from one another; however, the calf feeding system was  $\$2.49$ /steer numerically more profitable than the yearling system. Furthermore, standard deviation of profits for calf-fed and yearling production systems was  $\$99.04$ /steer and  $\$160.86$ /steer, respectively, indicating yearling systems have greater economic risk. The study also evaluated the profit risk associated with each of the three phases within the yearling system. The majority of profit in the yearling system was the result of economic returns from summer grazing. Therefore, results from this study indicate that a producer should focus on summer grazing phases in order to maximize profitability from yearling systems. Standard deviation of returns for the winter, summer, and finishing phases of the yearling production system was  $\$43.41$ ,  $\$83.07$ , and  $\$113.60$ /steer, respectively, implying that the economic risk associated with finishing yearlings is greater than backgrounding yearlings. Thus, the decision of switching between beef production systems or phases depends on a producer's risk aversion level.

**Key Words:** production systems, yearling, economic risk

### 56 The economic impact of increasing corn price and supplementation decisions on economics of beef production systems.

W. A. Griffin\*, T. J. Klopfenstein, G. E. Erickson, D. R. Mark, and K. M. Rolfe, *University of Nebraska, Lincoln*.

Eight-years of data comparing calf-fed and yearling production systems were utilized to determine differences in profitability with increasing corn prices and supplementation decisions prior to feedlot entry. Profit-

ability was calculated using 2007 prices for grazing cost, ingredients other than corn, and fed cattle price. Corn was priced at  $\$2.50$ ,  $\$4.50$ , and  $\$6.50/25.6$  kg. Initial calf purchase price was determined assuming calf-feds (enter feedlot at weaning) were a breakeven opportunity. Yearlings grazed cornstalks during winter to early spring and grazed Sandhills range from early spring to late summer. At the conclusion of the grazing season yearlings were finished in the feedlot. Three different winter supplementation practices were evaluated for the yearling system: supplementing with  $2.6$  kg of corn and supplement (CORN),  $2.2$  kg of wet corn gluten feed (WCGF) priced at 90% the price of corn, and  $1.8$  kg of wet distillers grains (WDGS) priced at 70% the price of corn. When corn price was  $\$2.50$  and  $\$4.50/25.6$  kg, yearlings fed CORN ( $P > 0.61$ ) and WCGF ( $P > 0.19$ ) were similar in profitability compared to calf-feds. When corn price was  $\$6.50/25.6$  kg yearlings fed WCGF were  $\$46.45$ /steer ( $P = 0.04$ ) and CORN was numerically  $\$31.62$ /steer more profitable ( $P = 0.13$ ) than calf-feds. When yearlings were supplemented WDGS, profitability was not different for yearlings when corn price was  $\$2.50/25.6$  kg ( $P = 0.30$ ). However, profitability was greater for yearlings fed WDGS compared to calf-feds when corn price was  $\$4.50$  ( $P = 0.03$ ) and  $\$6.50/25.6$  kg ( $P < 0.01$ ). As corn price increased profitability for long yearlings compared to calf-feds increased when yearlings were supplemented CORN ( $-\$11.08$  to  $\$31.62$ /steer), WCGF ( $\$9.19$  to  $\$46.45$ /steer), and WDGS ( $\$22.70$  to  $\$81.56$ /steer). From this study we conclude that as corn prices increase supplementation programs can have a large impact on profitability differences between calf-fed and long yearling programs.

**Key Words:** beef production systems, corn price, supplementation

### 57 Impact of supplementing modified wet distillers grains with solubles to long yearling steers grazing native range.

K. M. Rolfe\*, M. K. Luebbe, W. A. Griffin, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln*.

Two hundred forty long yearling steers ( $BW = 229 \pm 16$  kg) were used to determine the effects of supplementing modified wet distillers grains with solubles (MDGS) while grazing native range (warm season grass). Steers were backgrounded on cornstalk residue from late fall to mid-spring (144 d). While grazing cornstalks calves were supplemented  $2.27$  kg/steer daily of wet corn gluten feed. Following backgrounding steers were allowed to graze smooth brome grass pastures for 21 d. After grazing smooth brome calves were weighed, stratified by BW, assigned randomly to summer grazing treatments, and relocated to graze Sandhills range. Summer grazing treatments included: grazing native range with no supplementation (CON); and grazing native range with MDGS supplementation at a level of  $0.6\%$  BW (SUPP). Modified distillers grains with solubles was fed daily on the ground. Steers were allowed to graze Sandhills range for the remainder of the summer grazing period (136 d) before entering the feedlot in early fall. Initial and final BW for summer were the mean of two weights taken on consecutive days following a 5-d limit feeding period. At the time of summer treatment assignment, BW was not different between SUPP and CON steers ( $P = 0.47$ ). However at feedlot entry, SUPP steers were  $53$  kg heavier ( $P < 0.01$ ) than CON steers. Therefore, SUPP steers had  $0.37$  kg greater ( $P < 0.01$ ) ADG than CON steers. Using the NRC energy equation,  $0.29$  kg grass was saved for every  $0.45$  kg MDGS (DM) fed. In this study, supplementing MDGS at  $0.6\%$  BW to long yearling steers grazing native range increased ADG during summer grazing. Additionally, a meta-analysis of 12 experiments where dried distillers grains with solubles (DDGS) were fed in a bunk found a quadratic response to gain from DDGS ( $y = -0.0124x^2 + 0.1866x + 1.507$ . Linear  $< 0.01$ ; Quadratic =

0.17). However, these data suggest that response to gain from MDGS exceeds that of DDGS.

**Key Words:** modified wet distillers grains, supplementation, yearling steer

**58 Comparison of corn co-products/corn residue bales and alfalfa hay on cow performance, lactation, and economics.** T. J. Braungardt<sup>\*1</sup>, D. B. Faulkner<sup>1</sup>, D. W. Shike<sup>1</sup>, K. Karges<sup>2</sup>, M. Gibson<sup>2</sup>, and N. M. Post<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*Dakota Gold Research Association, Souix Falls, SD*.

Sixty-five Angus and sixty-nine Simmental cows were utilized to determine the effects of three co-products and one hay diet on performance, lactation and economics. Feedstuffs used were: traditional distillers dried grains with solubles (BPX), high-protein low-fat distillers dried grains (HP), corn bran (Bran), high-quality alfalfa mixed hay (Hay), and corn residue bales. Cows were randomly allotted to one of four dietary treatments at calving: 1) BPX; 2) Bran/BPX; 3) Bran/HP; or 4) Hay. Co-product diets(1,2,3) included ad libitum access to corn residue bales and were formulated to be isocaloric to meet cow maintenance and lactation energy requirements. Cows were blocked by breed and calving date. Calf birth weights and cow weights after calving and prior to feeding were used as initial weights. Milk production was estimated using the weigh-suckle-weigh (WSW) technique at 57 days postpartum. Cow and calf weight at 65 days was used to calculate calf ADG and cow weight change. Six cows from each treatment were milked using a commercial milking machine to determine milk components. Treatments were compared using single degree of freedom orthogonal contrasts (BPX vs. Bran/BPX and Bran/HP, Bran/BPX vs. Bran HP, and Hay vs. BPX, Bran/BPX, and Bran/HP). Cows fed Hay lost more body weight ( $p=.01$ ) compared to the co-product diets but there was no difference in milk production, calf ADG, reproductive performance, or manure production in any of the contrasts. The Bran diets were less expensive than the BPX (\$2.18 vs. \$2.25/cow/d, respectively;  $p<.01$ ), and the Hay diet was more expensive than the co-product diets (\$3.87 vs. \$2.14 /cow/d, respectively;  $p<.01$ ). Feeding high levels of corn co-products with ad libitum corn residue bales resulted in acceptable performance and will reduce feed cost compared to traditional ad libitum hay diets.

**Key Words:** corn residue, co-products, cow-calf

**59 An economic budget for determining co-product storage costs.** J. A. Waterbury<sup>\*</sup>, D. R. Mark, R. J. Rasby, and G. E. Erickson, *University of Nebraska, Lincoln*.

The seasonal decrease in co-product price during the late summer months provides incentive for producers to purchase co-product and store it to feed at a later date. Storing co-products is also a natural procurement and price hedge. By physically owning the commodity, producers are protected against the risk of being able to obtain the co-product at any price level. Although several storage methods exist, research has shown that successful storage of co-products can be accomplished using a silo bag or a bunker. Because co-product storage costs, which include shrink, co-product and forage costs, and equipment costs, will vary among operations and type of storage method, producers must recognize and define the storage method that is optimal for their own operation. In

doing so, producers must also ensure that the benefits of actually storing the co-product exceed the costs to do so. The objective of this project was to develop Co-Product STORE (Storage To Optimize Ration Expenses) to help producers evaluate the cost of co-product storage associated with their own operation. Co-Product STORE is an electronic budget organized into four steps that allows individuals to provide several inputs specific to their own operation. Using the inputs, the budget generates a results summary that includes total storage cost, total mixture and shrink costs per ton, and feed tonnage as well as mixture costs per pound of total digestible nutrients and per pound of crude protein. Based on assumed storage costs calculated by Co-Product STORE in late July 2008, co-product storage did not appear to be the optimal choice as the contracted price for wet distillers grains plus solubles was nearly \$32 per ton and \$51 per ton (dry matter basis) less than bag and bunker co-product costs per ton with shrink, respectively. Because storage costs can be quite significant, knowledge of a contracted co-product price is critical to making storage decisions. Co-Product STORE is designed to help producers address these issues by evaluating specific storage scenarios in response to changing market conditions.

**Key Words:** economic budget, storage, wet distillers grains

**60 Development of a maturity index as a predictor of first pregnancy probability.** M. C. Stockton<sup>\*1</sup>, R. K. Wilson<sup>1</sup>, L. A. Stalker<sup>1</sup>, D. M. Feuz<sup>2</sup>, and R. N. Funston<sup>1</sup>, <sup>1</sup>*University of Nebraska, Lincoln*, <sup>2</sup>*Utah State University, Logan*.

Assessment of a beef heifer's breeding maturity has typically been measured as the weight of the replacement heifer at first breeding expressed as a percent of mature body weight (PMBW). Converting the measure to a percentage makes it applicable over the many different biological types of animals typically found throughout the beef cattle industry. Actual mature weight for beef cattle is not observable until an animal is between four and five years of age, long after first breeding, making it impossible to know the true PMBW. Since the individual animal's true mature weight is not yet available, the herd average is often used which introduces error into the measure. Other factors such as age, dam milking ability and post weaning nutrition can also impact the weight at which they reach breeding maturity. Data from 302 heifers were used to evaluate three different methods of predicting breeding success. The first was the traditional method where the weight of the heifer was divided by the herd average (TPMBW). The second was the weight of the heifer divided by her dam's mature weight (PDMBW). The third was a Maturity Index (MI) where a model for estimating PMBW was created using ordinary least squares (OLS) as specified by an Akaike loss function. The model with the best in-sample performance, as measured by the mean absolute percent error, was the result of the OLS regression that contained five statistically significant ( $P < .05$ ) independent variables: the heifer's weight and age at breeding, her dam's mature weight, her birth weight, and her nutrition level from weaning to breeding. Further analysis using a limited dependant variable model of the Probit type used to predict pregnancy demonstrated that MI was a more accurate predictor of pregnancy than the other two measures and was also more accurate than using an animal's actual PMBW. The use of a maturity index may allow for a more accurate predictor of pregnancy since it includes additional information.

**Key Words:** beef heifer, reproduction, maturity index

# Joint Swine Extension I and Animal Behavior, Housing, & Well Being II Symposium

## Gestation Sow Housing: Current Understanding and Considerations

**61 Introduction to the sow gestation housing issue.** M. H. Whitney\*, *University of Minnesota Extension, Mankato, MN.*

Sow housing is one of the most contentious welfare issues facing the swine industry in the U.S. Public interest and scrutiny over animal production methods and sow housing systems, primarily the individual gestation crate, has resulted in significant attempts to change current methods for raising pigs. European regulations have already banned the use of tethers for sows and have mandated phasing-out of gestation stalls by 2013. Recently several states in the U.S. have also passed referendums to phase-out the use of individual stalls during gestation. Several larger integrated swine production companies have responded with their own initiatives to phase out current methods of keeping gestating sows within their own systems. Many of these changes are truly by trial-and-error due to the lack of scientific data and information that provides guidelines on whether to change and if so how to change from an individual gestation stall system to a system viewed publicly as more welfare-friendly. Moreover, no one system has been identified that truly enhances the well-being of the gestating sow. This proposed symposium will provide a current summary of how the sow housing issue has evolved, scientific evidence about the impact that sow housing has on animal welfare, and other considerations regarding genetics, feeding, equipment, labor, and overall management of production facilities. Additionally, both American and European perspectives and experiences regarding use of different sow housing systems, including planning, management, and economics, will be presented.

**Key Words:** gestation, sows, housing

**62 Current knowledge and understanding regarding sow welfare.** J. L. Salak-Johnson\*, *University of Illinois, Urbana.*

The term “sow keeping” refers to accommodating and caring for breeding, gestating, and lactating sows. But the sow-housing issue refers for the most part to “should pregnant sows be kept individually or in groups?” How we keep gestating sows continues to be a contentious issue in North America and Europe. Despite the pressure being promoted by special interests groups and some niche-market producers to move from crates to group pens, some producers have resisted change. But with the success of state-by-state referenda (e.g., Florida, Arizona, California) being passed and selected market-savvy pork producers announcing the phasing out of crates, producers may not have a choice. A variety of system alternatives have been proposed and tried, but neither a set of acceptable group systems nor an ideal group system has been identified. So far, results of industry and scientific research from around the world indicate that alternative keeping systems do not necessarily result in improving sow well-being, but have been deemed acceptable. No one system has been identified as being better than others based on current notions of sow welfare. Data indicate that sows kept in crates as compared to group pens have similar values across measurement perspectives. All housing systems have advantages and disadvantages, thus each producer must decide, based on scientific information, the design components that should be implemented based on their situation and goals. Housing systems that have both individual and group interaction opportunities may be a reasonable outcome that satisfies animal welfare concerns and provides protection for submissive sows during feeding and early pregnancy. Accurate and well-defined assessment of farm animal well-being, using scientifically sound approaches that are economically

feasible are crucial to the sustainability of animal agriculture. Our scientific knowledge and understanding of the elements of group housing systems that impact sow welfare must be increased if we are to make informed policy decisions while sustaining animal agriculture.

**63 Genetic considerations for different sow housing options.** R. O. Bates\*, *Michigan State University, East Lansing.*

The American Veterinary Medical Association and the American Association of Swine Veterinarians have conducted in-depth literature reviews regarding group and individual housing of dry sows and have issued position statements which indicate that these two housing systems are essentially animal welfare neutral. This has been further substantiated by several pork industry groups and individual scientists since these position statements were issued. Yet, multiple states have passed legislation regulating the use of individual stalls for gestating sows and limit the duration sows can be housed individually in stalls. Multiple management options are under review and management recommendations formulated to assist pork producers in those states who must switch from individual to group sow housing systems. As group housing strategies are formulated for the modern pork industry, the genetic component regarding sow adaptation in group housing systems is under discussion. Crosses of different sow breeds have been shown to differ in retention rate when sows were housed in groups in comparison to their counterparts housed individually in stalls. Several studies have reported a heritable component to various aspects of sow behavior and temperament. These reports provide assurance that there is genetic influence on aspects regarding sow adaptability to group housing. As the pork industry is forced to group house sows, issues regarding social interaction, temperament and aggression among sows and of sows with stock persons will be considered within the genetic selection scheme along with how these characteristics relate to traditional selection criteria (e.g. number born alive, litter 21 day weight, return to estrus, growth, carcass merit, etc.) in maternal lines and breeds. Furthermore, the optimum conformation of sows housed in groups may differ from sows housed individually in stalls which may change how conformation is incorporated into selection programs. Future maternal selection schemes will consider aspects of behavior and conformation that improve the adaptability of sows to differing group housing environments.

**Key Words:** sow, housing, genetics

**64 Feeding, labor, and management considerations with different sow gestation housing systems.** D. G. Levis\*, *University of Nebraska, Lincoln.*

Housing sows individually in stalls or in groups of animals are the main two methods of housing gestating sows. The major problems in group-housing systems are controlling individual sow feed intake, excessive aggression and adverse effects on welfare. The structures for feeding sows in a group include feeding on a solid floor, feeding in a trough, electronic sow feeder, body length feeding stall (lockable or non-lockable), and shoulder length feeding stall. The dispensing of feed in a group environment is accomplished by dropping the entire amount of feed once per day in 2 or more piles, slowly dispensing the entire amount of feed at 80 to 120 g/min once per day on the floor or in a shoulder length feeding stall, and feeding the sows 2 to 6 times

per day on a solid floor with the total amount of feed being equally divided between the number of meals. The work tasks involved with group-housing of gestating sows include feeding; moving sows and boars; checking for estrus; removing open sows from pens; performing pregnancy diagnosis; vaccinating sows and gilts; checking functionality of watering, feeding, heating and cooling systems; removing manure and bedding from solid floors; managing injured sows and gilts; locating specific animals within a pen; managing cull sows; and closely observing sows at time of mixing for serious injuries. The efficiency of performing these work tasks depends on the design of the gestation facility and stockmanship abilities of workers. People working in group-housing facilities need to have excellent observation skills to locate sick or injured sows and sows not consuming adequate nutrition. Sow farms using group-housing of gestating sows should develop educational and training materials for workers. Many workers have little or no experience working with sows and boars. Workers need to be very careful when working within pens of group-housed sows. If a worker gets seriously injured or becomes unconscious and cannot get out of the pen, serious consequences can result.

**Key Words:** gestation, sows, group-housed

**65 Experiences with pen gestation sow housing from an American pork production system.** R. W. Ivey\*, *Maxwell Foods, LLC, Goldsboro, NC.*

Maxwell Foods, LLC, formed in 1989, is a large integrated pork production system with about 80,000 sows located in Southeastern U.S. Unlike most breeding herd systems in the U.S., all sows are housed in pens during gestation. Although stalled gestation was not a significant welfare issue in the U.S. at the time, animal welfare pressures being waged in Europe influenced the Maxwell Foods system design, as it was anticipated that these issues would impact U.S. production schemes in the future. In the Maxwell system, newly weaned sows are moved to a row of individual stalls adjoining a breeding pen which is used for estrous detection. Thirty-five d after sows are artificially inseminated, they are pregnancy checked, and if confirmed pregnant, are sorted by size and parity into five sow (or six gilt) partially slatted pens measuring  $2.44 \times 3.05$  m each. Sows farrow in conventional stalls. A summary of reproductive performance from 80,000 sows over a 3-month period (May - July 2008) includes: 87.8% farrowing rate, 10.9 pigs born alive/litter, 9.4% pre-wean mortality, 25.94 pigs weaned/mated female/year, 6.25 kg average weaning wt, and average weaning age of 19.2 d. Sow mortality rates averaged 5.3%, with an average parity of 3.2 and 35.1 non-productive d. Benefits of pen gestation housing include better water

intake, less maintenance of equipment and flooring, improved sow condition, and stable disease subpopulations while minimal stress effects from mixing and fighting due to stall housing first 35 d of pregnancy. Additionally, sows that are open when placed in pens are easily recognized when recycling. Our observations indicate that docile females are necessary for the pen gestation system to work. In summary, use of small-group pens during gestation, in conjunction with individual stall housing the first 35 d of pregnancy, have provided excellent sow welfare without negatively affecting breeding herd performance in our large, integrated pork production system.

**Key Words:** gestation, sows, pen

**66 Group housing systems for gestating sows: The European perspective.** B. K. Pedersen\*, *Danish Farm Design A/S, Forskerparken 10, DK-5230 Odense M.*

EU animal welfare legislation has brought about significant changes in housing of pigs in Europe requiring that gestating sows be group-housed from 4 wk post-mating until 1 wk before farrowing. The EU regulation on animal welfare outlines the minimum requirements that all member states must respect, while individual states may apply stricter rules nationally. Thus, some countries such as the UK, the Netherlands, and Sweden require that sows be group-housed from weaning until the next farrowing. The new legislation has been in force for new and remodelled sow accommodations since 2003 and by 2013 all gestating sows must be kept in groups. Advancement of the group-housing systems varies between member states with the northern European countries being ahead of the southern ones. Thus, 75% of Danish gestating sows are group-housed, while less than 20% of the Spanish sows are kept in groups. The new animal welfare requirements have stimulated substantial innovation and development of new housing systems for gestating sows. The various group-housing systems might be assessed according to their capacity of providing production assurance, e.g., high production performance and good animal welfare. Thus, Danish data indicate that first and foremost, a system must meet biological and management requirements including control of individual feed intake, enough space for sows to escape from aggressive pen mates, and pens must provide good footing, thus, reducing the risk of leg injuries. A variety of systems have been evaluated and results will be presented at the symposium. European animal welfare legislation is constantly undergoing transformation. Therefore, it is expected that future legislation will require that sows be kept loose throughout the entire production cycle.

**Key Words:** sow housing, legislation

## Extension Swine

**67 Effect of reduced nocturnal temperature for early-weaned pigs on performance and energy consumption.** R. C. Thaler\*<sup>1</sup>, L. J. Johnson<sup>2</sup>, M. C. Brumm<sup>3</sup>, and M. C. Shannon<sup>4</sup>, <sup>1</sup>*South Dakota State University, Brookings,* <sup>2</sup>*West Central Research and Outreach Center, University of Minnesota, Morris, MN,* <sup>3</sup>*University of Nebraska, Lincoln,* <sup>4</sup>*University of Missouri, Columbia,* <sup>5</sup>*NCERA-89 Committee on Swine Management.*

The objective of this project was to determine the effect of a reduced nocturnal nursery temperature regimen on performance of early-weaned pigs and energy consumption during the nursery phase. A common protocol was developed and 4 universities (South Dakota State Univ, Univ

of Minnesota, Univ of Nebraska-Lincoln, and Univ of Missouri) each ran two trials in the fall, winter or spring months. Two nursery rooms were used and the experimental treatments were: Control (CON - 30 C at pig height at weaning lowered 2 C per week) and Reduced Nocturnal Temperature (RNT - beginning on day 7 post weaning, target temperature lowered 6 C from 1900 to 0700 h from CON, but then returned to CON from 0700 to 1900 h). Prior to day 7, CON regimen was employed in the RNT treatment as well. Performance was measured weekly in the nursery phase (35-42 d), and electrical and heating fuel usage recorded weekly. Data from SDSU were dropped from the analysis due to a confounding factor within the building. PROC MIXED was used with the statistical model including temperature treatment, station, and trt ×

station as fixed effects and replicate as a random effect. A total of 1,258 weaned pigs weighing 6.2 kg were used in the 6 trials. Nursery ADG (.43 kg/d), ADFI (.62 kg/d), and Gain/Feed (.685) were identical for the CON and RNT pigs. There were no statistical differences in BTU usage/pig (405,447 vs 334,049) or Kwh usage/pig (5.6 vs 5.0) between CON and RNT treatments. However, the lack of significant treatment effects on energy usage could have been due to the large standard error associated with these two variables. Heating fuel use (BTU/pig) was numerically reduced by 17.4% and Kwh/pig was reduced by 9.5% for the pigs in the RNT treatment. Assuming these results are repeatable, producers can save money through lower propane and electrical costs by reducing nocturnal temperature the second week after weaning for early-weaned pigs without affecting growth performance. This project was funded by the National Pork Checkoff.

**Key Words:** nursery pigs, reduced nocturnal temperature, energy usage

**68 Construction resource use by swine facilities: Gestation and grow-finish.** P. J. Lammers\*, M. S. Honeyman, J. D. Harmon, J. B. Kliebenstein, and M. J. Helmers, *Iowa State University, Ames.*

This study evaluates key construction resources needed to build gestation and grow-finish facilities. Two types of facilities—conventional and hoop barn—within farrow-to-finish systems scaled to produce either 5,200 or 15,600 market pigs annually are examined. Conventional facilities are typical of pork industry practice in the US and are characterized by individual gestation stalls and 1,200 head grow-finish buildings with slatted concrete floors, mechanical ventilation, and liquid manure systems. The hoop barn alternative uses bedded group pens in hoop barns for gestation and finishing. Concrete, steel, lumber, thermoplastics, and insulation used to build the facility as well as land and diesel fuel needed for site preparation were estimated based on interviews with managers, industry consultants, and construction firms. Relative market costs of newly constructed gestation and grow-finish facilities were compared under several scenarios. Hoop barns for gestation and grow-finish result in lower construction costs per pig space. Increasing the scale of production lowers the construction cost per pig space, however the construction cost per pig space for a 5,200 market pig complex using hoop barns is less than the construction costs per pig space for a conventional 15,600 head system. Hoop barns for grow-finish and gestating swine are a lower cost alternative that are less dependent on scale of production.

**Table 1. Estimated construction costs of grow-finish and gestation facilities for swine<sup>1</sup>**

	Conventional	Conventional	Hoop Barn	Hoop Barn
Scale, market pigs/yr	5,200	15,600	5,200	15,600
Grow-finish, \$/pig space	317	213	89	90
Gestation, \$/sow space	1604	750	519	494

<sup>1</sup> Includes costs of purchasing land, site preparation, building materials, and construction labor.

**Key Words:** hoop barns, construction costs

**69 Evaluation of the growth of backfat depth, loin depth and carcass weight on different sire and dam lines.** A. Schinckel\*<sup>1</sup>, M. Einstein<sup>1</sup>, S. Jungst<sup>2</sup>, C. Booher<sup>2</sup>, and S. Newman<sup>2</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*PIC North American, Hendersonville, TN.*

The growth of 1990 barrows and gilts of three sire and two dam lines was evaluated over two replicates to parameterize the relationships of backfat and loin depth to BW. Pigs were weighed and ultrasonic backfat and loin depth measurements taken at approximate 28 d intervals from 37 kg BW to target BWs of 113, 127 or 141 kg. Carcass backfat and loin depths were measured with an optical probe. An exponential equation  $Y = \exp(b_0 + b_1BW + b_2BW^2) + a_i (\exp(b_0 + b_1BW + b_2BW^2))^D$  with a pig specific random effect ( $a_i$ ) provided the best fit of the ultrasonic data to BW based on AIC values of mixed model regression analyses. Ultrasonic backfat depths were affected ( $P < 0.01$ ) by replicate, dam line and interactions of replicate by BW and dam line by BW. Ultrasonic backfat depths of the gilts increased at a rate of 0.0077 cm/kg BW gain at 40 kg BW to 0.0115 cm/kg at 135 kg BW. Barrows had backfat growth rates of 0.0110 cm/kg BW gain at 40 kg BW which increased to 0.0149 cm/kg BW gain at 115 to 125 kg BW. Ultrasonic loin depths were affected ( $P < 0.05$ ) by replicate, sire line, and replicate by BW and sire line by BW interactions. Carcass backfat and loin depths were impacted ( $P < 0.01$ ) by replicate, sire line, dam line, target BW, sex and sire line by sex interaction. Pigs of different sire and dam lines have different rates of backfat and muscle growth indicating differences in compositional growth.

**Key Words:** pig growth, ultrasound, backfat

**70 Evaluation of different mixed model nonlinear functions to describe the body weight growth of pigs of different sire and dam lines.** A. Schinckel\*<sup>1</sup>, M. Einstein<sup>1</sup>, S. Jungst<sup>2</sup>, C. Booher<sup>2</sup>, and S. Newman<sup>2</sup>, <sup>1</sup>*Purdue University, West Lafayette, IN*, <sup>2</sup>*PIC North American, Hendersonville, TN.*

Growth rates of 1,932 barrows and gilts from three sire lines and two dam lines were collected over two replicates to evaluate different functions used to parameterize BW growth. The pigs were weighed at birth, weaning, 55 d of age and at approximate 28 d intervals from 74 to 158 d of age. Mixed models were evaluated for the Bridges, Gompertz and Generalized Michaelis-Menten (GMM) functions. Two pig-specific random effects were included in each function; one for predicted mature BW and one associated with the age in which maximum ADG was achieved. Alternative analyses were completed in which a random effect for a third parameter was predicted as a linear function of the random effect for mature BW. The three functions provided similar likelihood statistics, residual standard deviations, predicted BW and predicted ages to achieve 105 kg BW. Predicted ages and BW at maximal growth were greater and more variable ( $P > 0.01$ ) for the Bridges and GMM functions than the Gompertz function. The GMM predicted greater mature BW (379.3 kg) than the Bridges (238.7) and Gompertz (211.9) functions. Age at maximal growth, BW at maximal growth and days to achieve 105 kg BW were affected ( $P < 0.001$ ) by sire line and sex. Sire line by replicate and sex by replicate interactions ( $P < 0.05$ ) for the growth function parameters, age at maximal ADG, BW at maximal ADG and days to achieve 105 kg BW indicated genetic by environmental interactions.

**Key Words:** mixed effects model, nonlinear growth functions, pig growth

**71 Evaluation of the impact of pig birth weight on grow-finish performance.** A. Schinckel<sup>1</sup>, M. Einstein<sup>1</sup>, S. Jungst<sup>2</sup>, C. Booher<sup>2</sup>, and S. Newman<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>PIC North American, Hendersonville, TN.

A trial was conducted to evaluate the impact of birth BW on pig growth. Pigs (1932 barrows and gilts, three sire lines, two dam lines, two replicates) were weighed at birth, weaning, exiting the nursery, and at approximate 28 d intervals from 74 to 158 d of age. Daily feed intake (DFI) was recorded via an electronic feeder from 38 kg BW to end of test. The DFI data were fitted to a mixed-model Bridges function of BW and the BW data fitted to a mixed model generalized Michaelis-Menten function of days of age. The relationship of the pig growth variables to birth BW were evaluated via regression analyses at four BW (46.7, 64.6, 83.5, and 102.5 kg.) Pig ADG, predicted 158-d BW and days to 125 kg BW had linear-quadratic relationships ( $P < 0.001$ ) to birth BW in gilts and linear-quadratic-cubic relationships ( $P < 0.02$ ) to birth BW in barrows. Overall, approximately 10 to 13 percent of total variation in 158-d BW and days to 125 kg was accounted for by birth BW. Regression equations predicted that barrows and gilts with birth BW of 1.0 kg require 12.3 and 13.6 additional d to achieve 125 kg BW than barrows and gilts with birth BW of 2.0 kg. Regression equations predicted that increasing the birth BW of pigs with below average birth BW had greater impact to increase ADG than increasing the birth BW of pigs with average or above average birth BW. No relationships ( $P > 0.60$ ) were found between DFI and birth BW. Feed conversion (feed:gain) had linear and linear-quadratic relationships ( $P < 0.05$ ) to birth BW. Pigs with birth BW less than 1.1 kg had greater feed:gain, greater days to achieve 125 kg than pigs with birth BW greater than 1.1 kg.

**Key Words:** pig, growth, birth weight

**72 Evaluation of the impact of pig birth weight on grow-finish performance, backfat depth and loin depth.** A. Schinckel<sup>1</sup>, M. Einstein<sup>1</sup>, S. Jungst<sup>2</sup>, C. Booher<sup>2</sup>, and S. Newman<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>PIC North American, Hendersonville, TN.

A trial was conducted to evaluate the impact of birth BW on the growth of backfat, loin depth and predicted carcass lean percentage. Pigs (1932 barrows and gilts, three sire lines, two dam lines, two replicates) were weighed and ultrasonically measured at approximate 28 d intervals from 74 to 158 d of age and at market BW. An exponential equation  $Y = \exp(b_0 + b_1 BW + b_2 BW^2) + a_i (\exp(b_0 + b_1 BW + b_2 BW^2))^D$  with a pig specific random effect ( $a_i$ ) was used to fit the ultrasonic data to BW. Pigs were assigned to a 113, 127, or 141 kg final BW. Fat depth and loin depth were measured with an optical probe (Fat-O-Meater, SFK Technology) between the third and fourth ribs anterior to the last rib. The relationships of the measurements and predicted percent lean to birth BW were evaluated via regression analysis. There were no significant ( $P > 0.35$ ) linear relationships between ultrasonic backfat depth and birth BW for gilts. The ultrasonic backfat depths of barrows had significant linear-quadratic ( $P < 0.10$ ) relationships with birth BW. However, birth BW only accounted for 0.2 to 0.8% of the total variance in ultrasonic backfat depth at each BW. Ultrasonic loin depths at 46.7, 64.6, 83.5, and 102.5 kg BW had ( $P < 0.05$ ) linear-quadratic-cubic relationships with birth BW. Final ultrasonic and carcass optical probe fat depths had significant ( $P < 0.10$ ) linear ( $P < 0.04$ ) or linear-quadratic ( $P < 0.10$ ) relationships with birth BW. Pigs with less than average mean birth BW had greater final backfat depths than pigs with average or greater than average birth BW. Yet, only approximately 2 to 4% of the total variance in backfat depth (adjusted for BW) was accounted for by birth BW.

**Key Words:** pig, growth, birth weight

**73 Evaluation of different mixed model nonlinear functions to describe the feed intakes of pigs of different sire and dam lines.** A. Schinckel<sup>1</sup>, M. Einstein<sup>1</sup>, S. Jungst<sup>2</sup>, C. Booher<sup>2</sup>, and S. Newman<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>PIC North American, Hendersonville, TN.

Daily individual feed intakes (DFI) of 1,932 barrows and gilts from three sire and two dam lines were collected over two replicates to evaluate different functions used to parameterize DFI. Five functions relating DFI to age or BW were evaluated: linear-quadratic, exponential, generalized Michaelis-Menten (GMM), a nonlinear function  $C(1 - \exp(-Mt))$  and Bridges function  $C(1 - \exp(-\exp(Mt^A)))$  where  $t$  is age or BW. Based on AIC and RSD values, the Bridges function provided the best fit to DFI data. Two pig-specific random effects were included; one for mature DFI ( $C$ ) and one for  $M$ . Analyses were completed in which a random effect for  $A$  was predicted as a linear function of the random effect of  $C$ . The barrow and gilt data were fitted separately as their values for  $A$  were different ( $P < 0.05$ ). For DFI, there were overall significant effects ( $P < 0.05$ ) for replicate, sex and sire line by dam line interaction. Repeated measures analyses indicated significant ( $P < 0.001$ ) interactions of sire line, sex and replicate with age and BW indicating that the shapes of the DFI curves were different for the pigs of different sire lines, sexes and replicates. The research indicates that separate DFI curves are needed for each sire line and sex and season. Daily feed:gain (F:G) values were estimated for each pig using a GMM function previously fitted to the BW data. The analyses of F:G indicated significant ( $P < 0.05$ ) effects for sire line, dam line, sex, sire line by sex and sire line by replicate.

**Key Words:** feed intakes, pigs, nonlinear function

**74 Number of functional underline sections affects weaned piglet body weight and quality.** C. L. Yoder<sup>1</sup>, J. S. Fix<sup>1</sup>, J. W. Holl<sup>2</sup>, W. O. Herring<sup>2</sup>, J. M. Bender<sup>2</sup>, and M. T. See<sup>1</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Smithfield Premium Genetics Group, Rose Hill, NC.

At farrowing and weaning, commercial Large White  $\times$  Landrace sow ( $n = 376$ ) underline sections were evaluated for mammary gland and teat functionality to determine the effect on preweaning piglet performance. Underline sections were classified as functional if mammary glands filled the palm of the hand and teats had no visual injury or defect. Underlines were evaluated within 24 h of farrowing (FFU) and 3 d prior to weaning (WFU). Loss of functional underline sections (LFU) from farrowing to weaning was calculated for each sow. Pigs were cross fostered (CF) (12%) within 24 h of farrowing. Two d prior to weaning ( $18.7 \pm 0.03$  d of age), pigs ( $n = 3950$ ) were weighed and assigned a visual quality score (QS) (3 = healthy pig; 2 = slightly small (3.2-4.1 kg BW) and/or slightly unthrifty; 1 small ( $< 3.2$  kg BW) and/or unthrifty). Model for FFU, WFU and LFU included, fixed effect of farrowing date ( $n = 29$  d) and covariate of parity ( $2.98 \pm 0.10$ ). WFU model included covariate of lactation length (LL). LFU model included fixed effect for wean wk ( $n = 4$ ). Models to evaluate effects of WFU and LFU on individual piglet weaning weight (IWW) included, fixed effects of sex, CF status and farrow date; covariates of parity, total pigs weaned, linear and quadratic effects of birth weight and LL; interactions of CF  $\times$  LL and birth weight  $\times$  LL. Descriptive statistics (min, max, mean): FFU (8, 17, 12.7), WFU (3, 15, 9.0) and LFU (0, 9, 3.8). Parity was inversely related to FFU ( $P < 0.10$ ) and WFU ( $P < 0.05$ ). Regression estimates of parity on FFU and parity on WFU were  $-0.07 \pm 0.041$  and  $-0.39 \pm 0.05$ , respectively. Every 1 d increase in LL resulted in an estimated decrease of  $0.28 \pm 0.13$  WFU. Direct relationships between WFU and IWW and between WFU and QS were identified ( $P < 0.01$ ). IWW increased  $49.3 \pm 9.55$  g

per WFU increase. As WFU increased the odds of pigs being lower QS decreased (odds ratio: 0.869;  $P < 0.01$ ). One unit increase ( $P < 0.01$ ) in LFU of nurse sows resulted in piglets being an estimated  $53.48 \pm 8.5$  g lighter at weaning. Older parity sows had fewer FFU and WFU. Longer LL resulted in fewer WFU. Fewer WFU and greater LFU resulted in lighter pigs at weaning.

**Key Words:** functional teats, piglet growth, pigs

**75 Economic impact of removing pigs prior to marketing on remaining pig growth performance.** J. Y. Jacela\*, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

A total of 1,126 pigs (BW = 109 kg; 25 pigs/pen) were used in a 15-d study to evaluate the economic impact of removing the heaviest pigs (topping) prior to marketing the whole finishing group and determine its effect on growth performance of the remaining pigs. Pens were blocked by average BW within sex and randomly assigned to 1 of 3 treatments with 15 pens/treatment. Treatments were topping 0, 2, or 4 pigs per pen. After topping, pens were weighed again (d 0) to determine average pig weight. Pens were  $3.05 \times 5.48$  m and floor space/pig were 0.67, 0.73,

and 0.80 m<sup>2</sup> for pens with 0, 2, and 4 pigs topped/pen, respectively. Pen weights and feed intake were recorded on d 8 and 15 to determine ADG, ADFI, and G:F. All treatment groups were fed the same corn-soybean meal-based diet containing 5 ppm Paylean®. Total revenue (adjusted to 25 pigs/pen), feed cost, and margin over feed cost (MOFC) were calculated on a pen and pig basis. Average BW was similar ( $P > 0.50$ ) between treatments after topping (109.2, 108.3, and 107.3 kg). There were no topping by sex interactions ( $P > 0.33$ ). As more pigs were topped per pen, ADG and G:F increased (quadratic;  $P < 0.04$ ) from d 0 to 8 while ADFI increased (linear;  $P < 0.01$ ) from d 8 to 15. Overall (d 0 to 15), increasing the number of pigs removed per pen from none to 2 or 4 increased ADG (1.03, 1.14 and 1.17 kg; quadratic  $P < 0.02$ ), ADFI (2.83, 3.04, 2.94 kg; linear  $P < 0.03$ ), and G:F (0.37, 0.38, and 0.40; quadratic;  $P < 0.04$ ). There were no differences ( $P > 0.76$ ) in revenues between treatments, but feed usage and feed cost on a pen or pig basis was reduced (quadratic;  $P < 0.01$ ) as more pigs were topped per pen. The reduction in feed usage and cost did not affect MOFC. In conclusion, removal of the heaviest pigs prior to market improves growth performance of the remaining pigs compared to pigs from pens that were kept intact up to time of market, which may be due to the increased pig space after topping. The improvement in performance was the same whether 2 or 4 pigs per pen were removed.

**Key Words:** growth, marketing, swine

## Graduate Student Competitive Research Papers, M.S. Oral Division

**76 Use of crude glycerol, a biodiesel co-product, in diets for lactating sows.** S. J. Schieck\*<sup>1</sup>, L. J. Johnston<sup>2</sup>, B. J. Kerr<sup>3</sup>, S. K. Baidoo<sup>4</sup>, and G. C. Shurson<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>West Central Research and Outreach Center, Morris, MN, <sup>3</sup>USDA-ARS, Ames, IA, <sup>4</sup>Southern Research and Outreach Center, Waseca, MN.

An experiment was conducted to evaluate the dietary effects of crude glycerol in lactating sow diets on sow and litter performance. Mixed parity (range = 0 to 13) sows ( $n = 345$ ;  $253 \pm 24$  kg BW) were assigned randomly within gestation housing location and parity to 1 of 4 dietary treatments. The treatments were: a corn-soybean meal based diet (CON); CON + 3% glycerol (GLY3); CON + 6% glycerol (GLY6); or CON + 9% glycerol (GLY9). Dietary treatments were imposed on d 109 of gestation when sows moved into farrowing rooms. From d 109 of gestation until farrowing, sows received 2.25 kg/d of their assigned diet. At farrowing, sows were allowed *ad libitum* access to feed throughout lactation. Sows and litters were weighed on d 0 of lactation, after litter size was standardized within treatments to 10 pigs, and at weaning. Last rib backfat depth was recorded ultrasonically on d 0 and at weaning. Milk samples were collected at weaning from a randomly pre-selected group of sows ( $n = 84$ ; 21 sows/treatment). Dietary treatment tended ( $P < 0.08$ ) to influence ADFI. Inclusion of up to 9% crude glycerol had no effect on sow weight or backfat losses, wean-to-estrus interval for sows that returned to estrus by d 10 post weaning, litter size at weaning, or ADG of piglets. Dietary treatment had no effect on moisture, crude protein, crude fat, lactose, or ash content of sow's milk. Results from this study suggest that lactating sows fed diets containing up to 9% crude glycerol perform similar to sows fed a standard corn-soybean meal control diet.

**Table 1. Dietary effect of crude glycerol on lactating sow performance**

Trait	CON	GLY3	GLY6	GLY9	PSE
No. of sows	90	89	85	81	--
Average parity	4.5	4.4	4.2	4.2	0.14
Lactation length, d	19.1	18.9	18.7	18.8	0.14
ADFI, kg	5.92ab	6.06a	5.53b	5.83ab	0.14
Sow wt loss <sup>1</sup> , kg	1.03	2.12	2.81	2.05	1.21
Sow backfat loss <sup>1</sup> , mm	1.40	1.49	1.22	1.44	0.18
Wean to estrus <sup>1</sup> , d	5.47	5.40	5.60	5.24	0.11
Pigs weaned/litter	9.5	9.4	9.2	9.2	0.10
Piglet ADG, g	260	255	247	254	4.21

<sup>1</sup>Lactation length used as a covariate in statistical analysis. <sup>ab</sup>Means with unlike superscripts differ ( $P < 0.08$ ).

**Key Words:** glycerol, lactation, sow

**77 Evaluation of prepartum alternative oilseed meal supplementation on beef cow and calf performance.** F. D. Loehr\*, C. L. Loehr, S. I. Paisley, T. L. Smith, and B. W. Hess, *University of Wyoming, Laramie*.

Pregnant cross-bred Angus cows ( $n=99$ , BW  $654 \pm 66$  kg, BCS  $5.00 \pm 0.35$ ) were assigned to nine pens to determine effects of three prepartum oilseed supplementation strategies on cow performance, and on that of their calves. Initial weight, age and BCS of cows were similar ( $P = 0.78$ ) across pens, with one of three treatments randomly assigned to each pen. Diets consisted of  $11.6 \text{ kg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$  mixed hay and one of three supplementation treatments formulated to meet energy, protein and mineral requirements for cows in late gestation. Supplements consisted of either soybean meal and cracked corn (CONTROL), safflower and

soybean meals (SAFFLOWER), or camelina meal (CAMELINA). After a 57-d feeding study, cows were weighed and body condition scored before calving. Within 24-h of calving, calf and cow data were recorded. Postpartum cows with live calves were managed as one group. Cow weight and condition at branding (d 49) and weaning (d 241) were also noted. Data were analyzed in a completely randomized design with pen as the experimental unit. All treatments achieved similar ( $P = 0.48$ ; 22 kg, 0.38 kg/d) weight gain and increased ( $P = 0.86$ ; +0.17 BCS) body condition during the feeding study. Calving ease and birth weight were similar ( $P = 0.45$ ; 1.07 score and 42 kg, respectively) across treatments. Cows on CONTROL diet tended ( $P = 0.08$ ) to have lower BCS than did animals on the SAFFLOWER treatment, with CAMELINA intermediate (4.93, 5.05, and 5.00, respectively). Body weight and BCS of cows at 49-d postpartum were similar ( $P = 0.61$ ; 673 kg, 4.64 BCS) across treatments. Cows bred back at similar rates ( $P = 0.23$ , 90%), and death loss of calves was similar ( $P = 0.87$ , 8%) across treatments. Adjusted 205-d weaning weights ( $P = 0.80$ ; 273 kg) were similar across treatments. Alternative oilseed meal supplementation prepartum yielded similar results to traditional corn and soybean supplementation on cow performance and fertility and on calf weights and death loss.

**Key Words:** beef cattle, oilseed supplementation, performance

**78 Effect of progesterone (P) antagonist RU486 on uterine progesterone receptor (PGR) mRNA expression, embryonic development and ovarian function during early pregnancy in pigs.** D. J. Mathew\*<sup>1</sup>, E. M. Sellner<sup>1</sup>, C. S. Okamura<sup>1</sup>, R. D. Geisert<sup>1</sup>, L. L. Anderson<sup>2</sup>, and M. C. Lucy<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Iowa State University, Ames, IA.

Early embryonic development and maternal recognition of pregnancy depends on down-regulation of PGR in endometrial epithelium. The PGR down-regulation may begin with P acting through the PGR to cause Nuclear Factor- $\kappa$ B (NF- $\kappa$ B) activation which may inhibit PGR expression. The PGR antagonist (RU486) may prevent PGR down-regulation by blocking P and preventing NF- $\kappa$ B activation. To test this hypothesis, gilts were inseminated (d 0) and assigned to be treated as follows: RU486 (400 mg/d) on d 3, 4, and 5 (T1; n=10); RU486 on d 6 and 7 (T2; n=9); or control (C; n=11). Blood was sampled for plasma P analysis and the uterus and ovaries were collected after slaughter (d 8 or 12). Endometrial RNA was analyzed for PGR by RT-PCR with primers specific for either PGR isoform B (PGR-B) or PGR isoforms A and B (PGR-AB). Gilts treated with RU486 (T1 and T2) had heavier ovaries (17.9, 19.8, and 16.1 g [SEM=1.1]; T1, T2, and C;  $P < .05$ ), greater follicular diameters (5.6, 4.9, and 3.6 mm [SEM=.5];  $P < .01$ ), a tendency for a greater number of corpora lutea (16.8, 15.0, and 13.7 [SEM = 1.0];  $P < .07$ ) and greater plasma P in mid-cycle (25.2, 28.0, and 20.6 ng/mL;  $P < .05$ ; d 9 to 11). Uterine wt (g) was less ( $P < .05$ ) for T1 (608±46) compared with T2 (780±49) or C (785±44). Gilts with normal embryonic development differed between treatments (10, 78, and 82% for T1, T2, and C, respectively; chi-square=13.3;  $P < .001$ ). Treatment affected both PGR-B ( $P < .001$ ) and PGR-AB ( $P < .001$ ) mRNA expression similarly. The PGR-AB mRNA expression on d 8 and 12 (respectively) was greater in T1 (2.2±.3 and 1.8±.4) compared with C (.4±.3 and .6±.4). The PGR-AB for T2 pigs was .6±.4 and 1.3±.3 for d 8 and 12, respectively. RU486 prevented PGR down-regulation (T1), caused early embryonic loss (T1), and stimulated ovarian development (T1 and T2) relative to control. We conclude that RU486 can be used to model the molecular events surrounding PGR down-regulation in uterine endometrial epithelium.

**Key Words:** embryo, uterus, progesterone

**79 Efficacy of potassium bicarbonate for prevention of fatigue in market pigs.** J. R. Danielson\*, J. L. Reichert, J. A. Kane, and T. D. Crenshaw, University of Wisconsin, Madison.

Blotchy skin, labored breathing, vocal distress and muscle tremors are signs of exhaustion in pigs. Severely exhausted pigs may progress to fatigued pigs (downers) that refuse to move and exhibit metabolic acidosis. A 2x2 factorial design was used to evaluate the efficacy of KHCO<sub>3</sub> supplementation for prevention of acidosis. Following a 48 h water restriction, pigs (n=48, ~115 kg, 12 pigs/trial) were allowed 16 h access to either alkaline (ALK, 30.2 g KHCO<sub>3</sub>/L) or water (W) treatments. After 16 h, randomly selected pigs were either handled gently (GE, n=4/trial) or aggressively (AG, n=8/trial). AG pigs were moved through a 293 m course including intentional chute restriction 4X and a minimum of 8 shocks from an electrical prod. GE pigs were moved the same distance with a hurdle board, without chute restriction or electrical prod stimulation. Immediately after handling a venous blood sample was collected. Blood gas values (pH, base excess, HCO<sub>3</sub>) were reduced ( $P < 0.05$ ) in AG vs GE pigs; whereas electrolytes, anion gap (K+Na-Cl-HCO<sub>3</sub>), hematocrit, NH<sub>4</sub>, and lactate concentrations were increased ( $P < 0.05$ ). Thus, AG induced acidosis. However, ALK treatment of AG pigs was not sufficient to overcome acidosis induced by handling; as these pigs had increased lactate, NH<sub>4</sub> and anion gap ( $P < 0.05$ ) compared to AG handled W pigs. In contrast ALK treatment of GE pigs increased base excess but decreased lactate and anion gap compared to GE handled W pigs. ALK treatment had no detectable effects on carcass quality. However, AG handling increased redness of loin chops ( $P < 0.05$ ). In conclusion, KHCO<sub>3</sub> provided at 30.2 g/L did not prevent acidosis induced by aggressive handling of market pigs.

**Table 1. Treatments**

	ALK/GE	ALK/AG	W/GE	W/AG	RMS
pH <sup>abc</sup>	7.44	6.90	7.34	6.90	0.08
Standard BE, mmol/L <sup>b</sup>	8.31	-26.4	4.71	-25.5	4.64
Lactate, mmol/L <sup>abc</sup>	3.35	33.9	3.63	28.6	3.63
NH <sub>4</sub> <sup>+</sup> , mmol/L <sup>b</sup>	0.232	0.383	0.224	0.346	0.04
Anion Gap, mmol/L <sup>bc</sup>	12.9	40.9	13.6	36.9	3.07

Superscripts denote differences ( $P < 0.05$ ) between <sup>a</sup>ALK vs W; <sup>b</sup> AG vs GE; or <sup>c</sup> treatment X handling

**Key Words:** fatigue, acidosis, potassium

**80 Factors affecting progeny profitability in Simmental-Angus steers harvested at optimum endpoint.** A. L. Shreck\*<sup>1</sup>, C. O. Trejo<sup>1</sup>, J. W. Homm<sup>2</sup>, L. L. Berger<sup>1</sup>, and D. B. Faulkner<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Data from 1288 steers by known Simmental (n=39), Angus (n=10), or Simmental-Angus cross (n=21) sires were analyzed to determine the relative importance of sire, along with progeny performance and carcass characteristics in explaining variation in profitability across differing marketing strategies and input costs. Cattle were fed corn or corn-byproduct based diets (n=11) and harvested based on ultrasound data to optimize carcass value. Progeny profit data were analyzed using increasing corn price (\$2.63, \$3, \$4, \$5 / 25.5 kg) and increasing choice-select spread (\$5, \$10, \$15). When increasing corn price was used, cattle were marketed on three schemes: yield based grid (YG), quality based grid (QG), and live weight. All diet prices were adjusted to have similar cost of gain to avoid biasing sires that were not evenly distributed across diets. The dependent variable was profit per steer. Independent variables were F:G, HCW, yield grade, quality grade, sire, and diet. As corn price increased, variation explained by F:G in both

QG (25%, 26%, 26%, and 23 %) and YG (23%, 23%, 26%, and 28%) profit models was substantial. As corn price increased, the amount of variation explained by F:G increased across all marketing schemes. With increasing corn price, profit models accounted for: 65% (\$2.63), 64% (\$3), 64% (\$4), and 63% (\$5) of the variation for YG, 63% (\$2.63, \$3, \$4, and \$5) of the variation for QG, and 88% (\$2.63), 89% (\$3), 89% (\$4), and 88% (\$5) of the variation for live. Results from this study show that F:G and quality grade are major factors influencing profitability as corn price or choice-select spread increases. However, on a live basis, F:G and HCW are the primary factors influencing profitability. Sire, diet, and yield grade are minor factors that influence profit either as corn price or choice-select spread increases when steers are harvested to optimize carcass value.

**Key Words:** profitability, sire, steers

**81 Effect of maternal diet on fetal:maternal ratio of circulating amino acids, non-esterified fatty acids, blood urea nitrogen, and glucose concentrations in ewes.** L. A. Lekatz\*<sup>1</sup>, G. Wu<sup>2</sup>, L. P. Reynolds<sup>1</sup>, D. A. Redmer<sup>1</sup>, J. S. Caton<sup>1</sup>, and K. A. Vonnahme<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Texas A&M University, College Station.

We hypothesized the previously reported reduction in fetal wt, without a reduction in placental wt, resulted from decreased nutrient transport to the fetus. The objectives were to determine the effects of maternal diet on the fetal:maternal ratio of circulating glucose, amino acids, NEFA, and BUN concentrations. Pregnant ewe lambs (n = 54) were assigned to 1 of 8 treatments in a 2 × 2 × 2 factorial design: selenium (Se) level [initiated at breeding; adequate (ASe; 0.3 ppm Se) or high (HSe; 3.0 ppm Se)] and nutritional level [control (C) or restricted (R); fed to meet 100% or 60% of NRC recommendations] fed at different times of gestation [Mid (d 50 to 90) or Late (d 90 to 130)]. Blood samples were taken from ewes and fetuses on d 130 of gestation. Amino acids were analyzed in plasma samples, and glucose, NEFA and BUN were analyzed in serum samples. A Se × Late interaction showed the fetal:maternal ratio of glutamate was greater (P = 0.03) in HSe-C compared to ASe-C and HSe-R (2.39 vs. 1.49 and 1.74 ± 0.32) with ASe-R ewes being intermediate. A Se × Late interaction indicated a greater (P = 0.03) fetal:maternal ratio of glutamine in ASe-R compared to ASe-C and HSe-C ewes (2.71 vs. 1.31 and 1.88 ± 0.33). The Late-R group exhibited greater (P = 0.02) serine fetal:maternal ratio compared to Late-CON ewes (9.94 vs. 6.43 ± 1.07). There was a Se × Late interaction on glycine, with ASe-R having a greater (P = 0.03) fetal:maternal ratio compared to all other ewes (1356.61 vs. 1027.64, 1159.92, and 1192.66 ± 74.56 for ASe-C, HSe-C, and HSe-R, respectively). The Late-R ewes had a lower (P = 0.01) NEFA fetal:maternal ratio compared to the Late-C ewes (0.12 vs. 0.19 ± 0.02). The BUN fetal:maternal ratio was lower (P = 0.01) in the HSe compared to the ASe ewes (1.04 vs. 1.19 ± 0.04). The fetal:maternal glucose ratio did not differ (P = 0.14). These data indicate the fetal to maternal concentration gradient of metabolically versatile amino acids, NEFA, and BUN are affected by Se and nutritional level during late gestation, indicating a role for maternal diet impacting placental function.

**Key Words:** sheep, fetus, maternal nutrition

**82 Use of microarray to determine genes differentially expressed in muscle and subcutaneous fat of heifers never treated or considered chronically morbid after a 63-d preconditioning program.** J. Johnson\*, D. R. Stein, L. O. Burciaga-Robles, B. P. Holland, D. L. Step, U. DeSilva, and C. R. Krehbiel, *Oklahoma State University, Stillwater.*

The objective was to determine gene expression changes in growing heifers due to bovine respiratory disease (BRD) using microarray analysis. Tissue biopsy samples from the LM and s.c. fat (SCF) between the 12th and 13th rib from heifers never treated against BRD (HEALTHY; n = 5) and heifers classified as chronically morbid (CHRONIC; n = 5) were collected after a 63 d preconditioning program. CHRONIC was defined as animals receiving at least three antimicrobial treatments had a loss of BW during the previous 21 d on feed. Hybridizations utilizing a long oligo bovine array were performed. Preprocessing and normalization of data was accomplished using the R-project statistical environment with the Bioconductor and LIMMA packages through the GenePix AutoProcessor (GPAP 3.2). Significance level for differentially expressed genes was set at P < 0.01 with a twofold change or greater. Ontology analysis of the differentially expressed genes was carried out using GFINDER with emphasis on biological process and molecular function. To further elucidate the interaction(s) of annotated genes within the context of metabolic or signaling pathways, Ingenuity Pathways Analysis was utilized to identify the most relevant biological mechanisms, pathways and functions of the differentially expressed genes. Of the 186 differentially expressed genes in LM (143 down- and 43 up-regulated) and the 121 differentially expressed genes in SCF (44 down- and 77 up-regulated); 87 and 50, respectively, had known ontology. Differentially expressed genes were mapped to pathways involved in immunological functions, metabolism, catalytic activities, binding, proteolysis, apoptosis, translation, transcription, growth, and transport of nutrients. These differences in gene expression across tissues and between treatment groups will provide a better understanding of the impact BRD has on immune response and animal growth.

**Key Words:** animal growth, bovine respiratory disease, microarray

**83 Efficacy of varying phytase levels and development of a P release curve.** C. K. Jones\*<sup>1</sup>, M. D. Tokach<sup>1</sup>, B. W. Ratliff<sup>2</sup>, N. L. Horn<sup>3</sup>, S. S. Dritz<sup>1</sup>, R. D. Goodband<sup>1</sup>, J. M. DeRouchey<sup>1</sup>, and J. L. Nelssen<sup>1</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Enzyvia, LLC, Sheridan, IN, <sup>3</sup>JBS United, Inc., Sheridan, IN.

Two experiments used 184 pigs (PIC, 10.3 and 9.7 kg BW, respectively) to develop an available P (aP) release curve for commercial phytase products. In Exp. 1 and 2, pigs were fed a basal diet (0.06% aP) and two levels of added aP from inorganic P to develop a standard curve. In Exp. 1, 100, 175, 250, or 500 FTU/kg OptiPhos; or 200, 350, 500 or 1000 FTU/kg Phyzyme XP were added to the basal diet. In Exp. 2, 250, 500, 750, or 1000 FTU/kg OptiPhos; 500, 1000, or 1500 FTU/kg Phyzyme XP; or 1850 or 3700 FYT/kg Ronozyme P were added to the basal diet. Manufacturer guaranteed phytase levels were used in diet formulation. Diets were analyzed for phytase using both the Phytex and AOAC methods. Pigs were blocked by sex and weight and allotted to individual pens with 8 pens per treatment. Pigs were euthanized on d 21 and fibulas were analyzed for bone ash. In Exp. 1 and 2, pigs fed increasing inorganic P had improved (lin, P ≤ 0.01) G:F, and percentage ash. Pigs fed increasing OptiPhos had improved (Exp 1: lin, P < 0.001; Exp2: quad, P ≤ 0.01) percentage ash. Pigs fed increasing Phyzyme XP had improved (lin, P < 0.001) percentage ash. In Exp. 2, increasing Ronozyme P improved (quad, P ≤ 0.03) percentage ash. Using AOAC analyzed values and bone ash as the response variable, aP release for up to 1000 FTU/kg of *E. coli*-derived phytases (OptiPhos and Phyzyme)

can be predicted by the equation ( $y = -0.000000125x^2 + 0.000236245x + 0.015482000$ ) where x is the phytase level in the diet.

**Table 1.**

	Exp. 1			Exp. 2		
	Trt	AOAC, FTU/kg	Ash, %	Trt	AOAC, FTU/kg	Ash, %
Added aP, %	0		35.6	0		34.2
'	0.075		39.4	0.07		39.6
'	0.15		41.8	0.14		41.2
OptiPhos, FTU/kg	100	345	36.2	250	674	41.6
'	175	560	38.2	500	1227	41.9
'	250	729	38.6	750	1849	42.7
'	500	1509	41.1	1000	2479	43.6
Phyzyme, FTU/kg	200	214	37.0	500	369	37.1
'	350	407	39.0	1000	708	41.9
'	500	429	37.9	1500	1091	42.0
'	1000	1038	40.0	1850	1694	41.1
				3700	3778	42.3

**Key Words:** growth, nursery pig, phytase

**84 Effects of elevated levels of distiller's grains on performance and carcass characteristics in steers fed up to 70% distillers.** S. W. Reader<sup>\*1</sup>, R. L. Atkinson<sup>1</sup>, P. M. Walker<sup>2</sup>, J. M. Carmack<sup>2</sup>, and B. R. Wiegand<sup>3</sup>, <sup>1</sup>*Southern Illinois University, Carbondale*, <sup>2</sup>*Illinois State University, Normal*, <sup>3</sup>*University of Missouri, Columbia*.

The objective of this study was to determine effects of 70% (DM) inclusion of dried distillers grain with soluble (DDGS) on performance and carcass characteristics. Additionally, isocaloric and isonitrogenous diets versus 40% (DM) DDGS were compared to determine effects of equivalent nutrient versus by-product. Ninety-six Angus steers ( $292 \pm 35.83$  kg) were used in a completely randomized design, stratified by body weight to one of 16 pens, and randomly assigned to one of six treatments: 1) 80% corn:5% SBM:15% corn silage, fed as a negative control (CON); 2) 40% DDGS: 45% corn: 15% corn silage, fed as positive control (PCON); 3) PCON (d 0-84) switched to 70% DDGS:15% corn:15% corn silage on d 85 till finish (40/70); 4) d 0-84 on 70% DDGS:15% corn:15% corn silage switched to PCON d 85 till finish (70/40); 5) CON + SBM, isonitrogenous to PCON (N40); 6) CON + corn oil, isocaloric to PCON (E40). Steers were fed respective treatments until 80% graded choice or better by visual appraisal (168 and 213 days). Weight gains and ADG were greater ( $P \leq 0.01$ ) for N40 on d-84 compared to PCON pens. Switching steers to 70% DDGS on d-85 till finish decreased ( $P \leq 0.03$ ) both ADG and G:F compared to CON, PCON, and 70/40 treatments. There were no treatment or nutrient effects ( $P \geq 0.14$ ) on HCW, REA, marbling score, KPH, or liver abscesses. However, there was an effect ( $P = 0.05$ ) of N on rib fat with the N40 steers having 0.35 cm more fat compared to PCON steers. Energy increased ( $P = 0.04$ ) yield grade by 0.54 in E40 steers compared to PCON steers, while N tended ( $P = 0.06$ ) to increase yield grade by 0.51 in N40 steers compared to PCON. Yield grade tended ( $P = 0.09$ ) to be greater (0.40) for 70/40 steers compared to 40/70 steers. These data suggests 70% inclusion of DDGS is possible. Performance data suggest steers should be started at 70% inclusion then stepped down to 40% DDGS. Carcass data suggest to achieve leaner carcasses, steers should start at 40% inclusion of DDGS being stepped up and finished at 70% DDGS.

**Key Words:** carcass quality, performance, steers

**85 Vascular Endothelial Growth Factor (VEGF) mRNA isoforms are altered in bovine granulosa cells (GC) by circulating progesterone concentrations (P4) and may indicate follicle status and oocyte competence.** R. Slattery<sup>\*1</sup>, D. Clopton<sup>1</sup>, J. Wood<sup>1</sup>, R. Cushman<sup>2,1</sup>, and A. Cupp<sup>1</sup>, <sup>1</sup>*UNL, Lincoln, NE*, <sup>2</sup>*USDA-MARC, Clay Center, NE*.

Previously, Melengestrol Acetate (MGA) fed for 14 d (0.5mg/cow/d; < 1 ng/ml P<sub>4</sub>) resulted in persistent follicles with increased size, decreased number of GC/follicular fluid (FF) volume, and less fertile oocytes. An experiment was conducted to determine effects of circulating P<sub>4</sub> on amount of mRNA for pro- and anti-angiogenic VEGF isoforms in GC of dominant (largest estrogen active; DOM) and subordinate (next largest; SUB) follicles. The hypothesis tested was that DOM developed with MGA have reduced VEGF pro- to anti-angiogenic mRNA isoforms in GC compared to CIDR (control; 4-6 ng/ml of P<sub>4</sub>). Cows (n = 13) received prostaglandin F<sub>2</sub>α (PG) on d 1 and 7 and MGA for 14 d or GnRH on d 7 and a CIDR for 7 d (n = 14). On d 14, all cows received PG and CIDR's™ were removed. Ovariectomies were conducted 36 h post-PG and GC, FF and blood was collected for analysis. Data were analyzed using PROC MIXED of SAS with mean separation by LSD. MGA DOM (n = 13) were larger ( $P < .001$ ) and had decreased GC:FF ratio ( $P = .06$ ); but, E<sub>2</sub>:P<sub>4</sub> ratio did not differ from CIDR DOM (n = 14). Increased E<sub>2</sub> was present in DOM ( $P < .001$ ) compared to SUB (n = 16;  $1047.6 \pm 137$  vs. n = 14;  $161.4 \pm 140$  ng/ml) and P<sub>4</sub> was greater ( $P \leq .001$ ) in SUB compared to DOM (n = 14;  $259.0 \pm 44$  vs. n = 16;  $42.2 \pm 43$  ng/ml). Angiogenic VEGF164 isoform mRNA tended ( $P = .10$ ) to be increased in DOM compared to SUB, while VEGF165b isoform was greater ( $P = .05$ ) in SUB compared to DOM (n = 14;  $10.7 \pm 3$  vs. n = 16;  $2.5 \pm 3$ ). Furthermore, VEGF164:VEGF165b mRNA isoform ratio was greater in DOM (n = 16;  $1.1 \pm 0.2$  vs. n = 14;  $0.4 \pm 0.2$ ;  $P < .05$ ) vs. SUB. CIDR DOM (n = 14) tended ( $P = .08$ ) to have a greater VEGF164:VEGF165b ratio than MGA DOM (n = 12). From these results, VEGF pro- to anti-angiogenic isoform ratio is greater in GC from healthy, estrogenic, non-persistent follicles suggesting that ratio of VEGF mRNA isoforms is a good indicator of follicle status and oocyte competence.

**Key Words:** follicle status, progesterone, VEGF

**86 Effects of subacute dietary nitrate on production and gene expression in Suffolk ewes.** R. R. Cockrum<sup>\*1</sup>, K. J. Austin<sup>1</sup>, P. A. Ludden<sup>1</sup>, J. F. Taylor<sup>2</sup>, S. C. Fahrenkrug<sup>3</sup>, J. R. Garbe<sup>3</sup>, and K. M. Cammack<sup>1</sup>, <sup>1</sup>*University of Wyoming, Laramie*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*University of Minnesota, St. Paul*.

Livestock producers incur economic losses due to poor performance associated with nitrate (NO<sub>3</sub><sup>-</sup>) toxicity. Nitrate is metabolized to nitrite (NO<sub>2</sub><sup>-</sup>) in the rumen, and ruminants consuming high dietary NO<sub>3</sub><sup>-</sup> vary in ability to reduce excess NO<sub>2</sub><sup>-</sup> to ammonia. Accumulation of NO<sub>2</sub><sup>-</sup> leads to formation of methemoglobin, resulting in toxicity. Our objectives were to 1) confirm individual variation in response to subacute levels of dietary NO<sub>3</sub><sup>-</sup>, and 2) determine differences in plasma parameters and gene expression among individuals identified as tolerant or intolerant to elevated dietary NO<sub>3</sub><sup>-</sup>. Purebred Suffolk ewes ( $85.7 \pm 46.4$  kg BW) were administered a KNO<sub>3</sub> supplement (300 mg NO<sub>3</sub><sup>-</sup>/kg BW daily; n = 47) or control supplement (n = 8) for 8 d. Liver biopsies were performed prior to and after treatment. Blood samples were drawn prior to treatment, 12 h after initial NO<sub>3</sub><sup>-</sup> exposure, every 24 h for 8 d, and 3 d after cessation of treatment. Supplement intake was more variable in NO<sub>3</sub><sup>-</sup> treated ewes (CV = 59.3%) than in control ewes (CV = 13.6%). Six NO<sub>3</sub><sup>-</sup> tolerant and six NO<sub>3</sub><sup>-</sup> intolerant ewes were identified based upon performance and symptoms of toxicity. Daily supplement intake differed ( $P < 0.001$ )

between control (99%), tolerant (82%), and intolerant (23%) ewes. Daily  $\text{NO}_3^-$  intake was higher ( $P < 0.0001$ ) in tolerant (1.53% DM) than in intolerant (0.49% DM) ewes. No differences in weight change or plasma  $\text{NO}_2^-$ , cortisol, glucose, or vitamin A were observed. Plasma urea N did not differ between control and intolerant ewes, but was lower ( $P < 0.02$ ) in tolerant than in control ewes. Microarray analysis of hepatic tissue revealed differential expression ( $P < 0.05$ ) of 100 genes between intolerant and tolerant ewes, 83 genes between intolerant and control ewes, and 5 genes between tolerant and control ewes. Functional analyses of these genes showed themes of oxidoreductase and catalytic activity, metabolic processes, ion binding, and cell structure. These results confirm that individual response to subacute levels of dietary  $\text{NO}_3^-$  varies, and that differences in gene expression may contribute to differences in tolerance to  $\text{NO}_3^-$ .

**Key Words:** gene expression, production, nitrate

**87 Amino acid digestibility of corn distillers solubles-related co-products in growing pigs.** J. A. Soares<sup>\*1</sup>, H. H. Stein<sup>1</sup>, G. C. Shurson<sup>2</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>University of Minnesota, St. Paul.

The solubles component of distillers dried grains with solubles (DDGS) may contribute to the low and variable digestibility of lysine and other AA. Combining solubles and grains sometimes produces 'syrup balls' and their digestibility is unknown. The objective of this experiment was to determine apparent and standardized ileal AA digestibility of corn distillers solubles co-products and to determine if the presence of syrup balls in DDGS impacts AA digestibility. The ingredients evaluated were DDGS, intact syrup balls (ISB), ground syrup balls (GSB), condensed solubles (CS), and spray dried thin stillage (SDTS) obtained from the same ethanol plant. Condensed solubles is produced by evaporation of thin stillage (TS). These ingredients were used as the only source of AA in the experimental diets. In a duplicate 6 × 6 latin square with 7-d periods, the 6 treatments consisted of a N-free diet and 5 test ingredients. Pigs had 5-d of adaptation to each diet, and on d 6 and 7, ileal digesta were collected from the distal part of the ileum for 8 h. The AA digestibility of GSB and ISB were equal or higher than that of DDGS (Table 1). Digestibility of CS was lower than that of DDGS for total essential AA (EAA) but not for lysine. Generally TS had the lowest AA digestibility, perhaps due to heat damage during spray drying. In conclusion, the presence of syrup balls does not decrease AA digestibility of DDGS and the CS evaluated has EAA digestibility lower than DDGS.

**Table 1. Lysine digestibility in the diets<sup>1</sup>**

Item	Diet					SEM
	DDGS	ISB	GSB	CS	SDTS	
Lysine						
AID <sup>2</sup>	59.80 <sup>y</sup>	69.93 <sup>x</sup>	68.82 <sup>x</sup>	61.03 <sup>y</sup>	39.13 <sup>z</sup>	3.10
SID <sup>3</sup>	61.49 <sup>y</sup>	72.00 <sup>x</sup>	70.98 <sup>x</sup>	63.08 <sup>y</sup>	41.57 <sup>z</sup>	3.09
Total essential AA						
AID	73.53 <sup>x</sup>	75.86 <sup>x</sup>	75.75 <sup>x</sup>	57.20 <sup>y</sup>	51.35 <sup>z</sup>	2.02
SID	81.15 <sup>x</sup>	83.38 <sup>x</sup>	83.84 <sup>x</sup>	60.97 <sup>y</sup>	60.40 <sup>y</sup>	1.88

<sup>1</sup>Means within a row without a common superscript differ ( $P < 0.05$ )

<sup>2</sup>Apparent ileal digestibility <sup>3</sup> Standardized ileal digestibility

**Key Words:** corn distillers solubles, growing pigs, AA digestibility

**88 Maintenance energy requirements of gestating beef cows and rumen temperature, plasma concentrations of IGF-I, glucose, thyroxine, and calf performance.** C. L. Bailey<sup>\*</sup>, M. J. Prado-Cooper, E. C. Wright, R. P. Wettemann, G. W. Horn, L. J. Spicer, and C. R. Krehbiel, Oklahoma Agricultural Experiment Station, Stillwater, OK.

The effects of maintenance energy requirements (MR) on rumen temperature, postnatal calf growth, and concentrations of IGF-I, glucose, and thyroxine in plasma were determined in spring-calving Angus × Hereford cows ( $n = 37$ ). Nonlactating cows (4 to 7 yr of age) with a BCS of  $4.9 \pm 0.3$ , and BW of  $569 \pm 44$  kg, at days  $160 \pm 5$  of gestation were individually fed a complete diet for 8 wk in amounts to meet MR (Model 1, NRC 1996). After 2 wk, daily feed intake was adjusted weekly until constant BW was achieved (regression analyses). Final BCS averaged  $5.0 \pm 0.3$ . Daily MR averaged 0.0904 Mcal/kg BW 0.75/d. Rumen temperature was recorded hourly with rumen boluses (Smart Stock, LLC). Two blood samples were taken after constant BW was achieved on each of two consecutive days. There was a 25% difference in energy required for maintenance between the most and least efficient cows. Cows were classified based on MR as low (L;  $> 0.5$  SD less than mean, 0.0861 Mcal/kg BW 0.75/d), moderate (M;  $\pm 0.5$  SD of mean, 0.0902 Mcal/kg BW 0.75/d) or high (H;  $> 0.5$  SD more than mean, 0.0963 Mcal/kg BW 0.75/d). Rumen temperature and plasma hormone concentrations were analyzed using the MIXED procedure (SAS); calf performance was analyzed using the GLM procedure (SAS). Rumen temperature was not influenced ( $P = 0.23$ ) by MR (L =  $38.33^\circ\text{C}$ , M =  $38.05^\circ\text{C}$ , H =  $38.12^\circ\text{C}$ ; SE =  $0.13^\circ\text{C}$ ). Plasma concentrations of IGF-I ( $P = 0.86$ ), glucose ( $P = 0.96$ ), and thyroxine ( $P = 0.60$ ) were not influenced by MR. Calf BW ( $P = 0.64$ ), weaning weight ( $P = 0.72$ ), and ADG from birth to weaning ( $P = 0.65$ ) were not influenced by MR. Variations in MR of beef cows during mid to late gestation were not associated with rumen temperature, plasma concentrations of glucose, IGF-I, thyroxine, or subsequent performance of calves. Identification of cows that require less energy to maintain BW, while maintaining performance could improve efficiency of beef cattle production.

**Key Words:** beef cattle, rumen temperature, maintenance

**89 Effect of gonadotropin treatment on estrus expression and ovulation in seasonally anestrous weaned sows.** R. Manjarin<sup>\*</sup> and R. Kirkwood, Michigan State University, East Lansing.

The objective of this study was to test the hypothesis that treatment of extended seasonal post-weaning anestrous period in sows with follicle-stimulating hormone (FSH) and equine chorionic gonadotropin (eCG) 48 h later increase the estrous and ovulatory responses compared to treatment with a mixture of human chorionic gonadotropin (hCG) and eCG. A total of 87 multiparous sows (Hypor breed) that did not show estrus by d 7 post-weaning during July and August were selected and randomly allocated according to parity to four treatment-groups: 1) FSH on d 7 and 8 and eCG on d 9 (FSH + eCG;  $n=24$ ), 2) eCG alone on d 9 (eCG;  $n=20$ ), 3) hCG and eCG mixture on d 9 (hCG + eCG;  $n=23$ ), and 4) Control ( $n=20$ ). The FSH + eCG, eCG and hCG + eCG treatments consisted of intramuscular injections of 87.5 IU FSH (Folltropin<sup>®</sup>) and 600 IU eCG (Folligon<sup>®</sup>), 600 IU eCG alone, and 200 IU hCG plus 400 IU eCG (PG600<sup>®</sup>), respectively. All sows received daily boar contact for a period of 15 d after weaning to facilitate estrus detection. Blood samples were obtained on d 9 and 20 after weaning and serum was assayed for progesterone concentration. The absence of progesterone concentrations on d 9 and an elevation on d 20 to a minimum of 5 ng/mL was indicative of an ovulatory response to treatment. Overall, compared to Control, gonadotropin treatments (i.e., treatments FSH +

eCG, eCG and hCG + eCG) increased ( $P < 0.05$ ) expression of estrus (15.0 vs. 47.8 %, respectively) within 7 days. There was no difference in expression of estrus among gonadotropin-treated groups. Compared to Control, FSH + eCG, eCG and hCG + eCG increased ( $P < 0.05$ ) the ovulatory response (15 vs. 50, 35 and 43.4 %, respectively). These data do not support the hypothesis that administration of FSH followed by eCG improve the estrous and ovulatory responses compared to hCG + eCG. However, these data do indicate that gonadotropins can be used successfully to reduce the impact of seasonal anestrus on the ability to meet breeding targets.

**Key Words:** sows, anestrus, gonadotropins

**90 The nutritional value of expeller-pressed canola meal for grower-finisher pigs.** R. W. Seneviratne<sup>1</sup>, M. G. Young<sup>2</sup>, E. Beltranena<sup>1,3</sup>, L. A. Goonewardene<sup>1,3</sup>, R. W. Newkirk<sup>4</sup>, and R. T. Zijlstra<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, Alberta, Canada, <sup>2</sup>Gowans Feed Consulting, Wainwright, Alberta, <sup>3</sup>Alberta Agriculture and Rural Development, Edmonton, Alberta, <sup>4</sup>Canadian International Grains Institute, Winnipeg, Manitoba, Canada.

Expeller-pressed canola meal (EPCM) contains more residual oil than solvent-extracted canola meal. The EPCM might be an attractive feedstuff for swine, but has been poorly characterized nutritionally. In Exp. 1, 6 ileal-cannulated barrows (36 kg BW) were fed twice daily at 3 × maintenance either a 44% EPCM or N-free diet to measure energy and AA digestibility and calculate standardized ileal digestible (SID) AA and NE content. In 10-d periods with 5-d diet adaptation, 2-d feces collection, and 3-d digesta collection, 6 observations per diet were obtained. The EPCM contained (in DM) 38.5% CP, 13.3% ether extract, 2.24% Lys, 1.54% Thr, and 0.71% Met. Apparent total tract energy digestibility was 75.0% and the DE and NE content was 3.77 and 2.55 Mcal/kg (in DM), respectively. The SID AA content (in DM) was 1.77% Lys, 1.09% Thr, and 0.52% Met. In Exp. 2, 880 pigs (25 kg BW) housed in 40 pens were fed 4 dietary regimes with 0, 7.5, 15, and 22.5% EPCM, formulated to equal NE:SID Lys during 4 growth phases (g/Mcal; 4.04, d 0 to 25; 3.63, 26 to 50; 3.23, 51 to 77; 2.83, 78 to 90). For d 51 to 90, 22.5% EPCM was reduced to 18% due to decreased ADFI earlier. Overall (d 0 to 90), increasing dietary EPCM quadratically decreased ( $P < 0.001$ ) ADG and ADFI and quadratically increased ( $P < 0.01$ ) G:F. For 0 and 15% EPCM, respectively, ADG was 978 and 934 g/d, ADFI was 2.77 and 2.60 kg/d, and G:F was 0.366 and 0.373. Carcass backfat thickness and loin depth did not change due to EPCM. Pigs fed 15% EPCM reached slaughter weight 3 d after ( $P < 0.05$ ) pigs fed 0% EPCM. In conclusion, EPCM provides energy and AA; however, ADG was reduced 3 g/d per 1% of EPCM inclusion in diets formulated to equal NE and SID AA. Thus, inclusion levels of EPCM in swine diets should be targeted to ensure an expected growth performance.

**Key Words:** canola co-product, nutritional value, pig

**91 Does administration of anabolic growth implants to finishing beef cattle influence carcass attributes of cattle genetically indexed for enhanced beef palatability?** J. C. Galbreath<sup>1</sup>, R. J. Maddock<sup>1</sup>, G. P. Lardy<sup>1</sup>, V. L. Anderson<sup>2</sup>, C. S. Schauer<sup>3</sup>, N. L. Hall<sup>1</sup>, and E. P. Berg<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Carrington Research Extension Center, North Dakota State University, Carrington, ND, <sup>3</sup>Hettinger Research Extension Center, North Dakota State University, Hettinger, ND.

This study's objective was to determine if administration of anabolic growth implants to finishing beef cattle influences carcass attributes

of cattle genetically indexed for enhanced beef palatability. Growth performance and carcass data were collected for 77 Angus-sired calves assigned to two treatment groups during the finishing period. Cattle in Treatment 1 (IM 17 steers, 22 heifers) received an implant containing 100 mg trenbolone acetate and 14 mg estradiol benzoate (Synovex Choice, Wyeth Animal Health) at weaning and again during the finishing period. Controls (NOIM 19 steers, 19 heifers) received no implant at any time. Weights were recorded on arrival and every 42 d until harvest. Tissue samples were collected for commercial IGENITY (Merial Ltd.) genetic profile indexing for carcass traits that included tenderness and percent USDA Choice. Cattle were fed to a common end weight (500 kg) and harvested on two dates. Carcass measurements were collected 24 h postmortem. Longissimus samples were collected at the 12th rib for Warner-Bratzler shear force (WBS) which was measured 16 d postmortem. Average daily gain and hot carcass weight (HCW) were greater for the IM treatment ( $P < 0.01$ ). No differences ( $P > 0.05$ ) were observed for ribeye area, fat thickness, KPH, yield grade, marbling, or WBS between IM and NOIM treatments. Least squares means was used to determine treatment effect on WBS and marbling relative to genetic potential for tenderness, marbling, and percent choice respectively. IGENITY results for cattle were sorted into low, medium, and high potential for each trait tested. No differences ( $P > 0.05$ ) were observed among cattle indexing high (IGENITY tenderness 8-10) across IM/NOIM. Cattle indexing high for percent choice had higher marbling scores than medium ( $P < 0.01$ ) and low ( $P < 0.05$ ) indexing cattle. The trends observed in this study suggest that anabolic implant use did not hinder genetic potential for tenderness, percent choice, or marbling. Future research is necessary utilizing a larger sample size with greater genetic diversity.

**Key Words:** anabolic growth implant, genetic profile, tenderness

**93 Associations of placental efficiency and nutrient transporter expression in the pig.** T. A. Wilmoth\*, C. O. Lemley, J. M. Koch, and M. E. Wilson, West Virginia University, Morgantown.

Placental efficiency is a gross measurement of the grams of fetus that can be supported per gram of placenta. Within a litter, similar size fetuses can grow on placentae that are small and efficient or large and inefficient. Although 50% of the variation in placental efficiency appears to be due to differences in vascular density, there is currently no explanation for the other half of the variation. Therefore, the objectives of the current experiment were to characterize the expression of nutrient transporters in the placenta at day 70, 90 and 110 of gestation and to determine associations between the expression of these transporters and placental efficiency. Gilts were randomly assigned to ovario-hysterectomy on day 70, 90 or 110 of gestation. At the time of ovario-hysterectomy, fetal weight and placental weight were recorded and used to calculate placental efficiency (piglet weight divided by fetal weight). For each conceptus, placental and endometrial tissues were collected and snap frozen. Real-time PCR was used to determine mRNA expression of nutrient transporters, including: rBAT-1, FAT-1, FAT-2, yLAT-1, CAT-1, ASCT-1 and GLUT-3. Placental weight increased ( $P < 0.05$ ) from day 70 to day 90 and 110 (124±6, 173±6 and 205±7, respectively). Fetal weight also increased ( $P < 0.05$ ) with day (216±6, 6001±11 and 1152±34, respectively). Placental efficiency increased ( $P < 0.05$ ) during the last 40 days of gestation as well (1.9±1, 3.7±1 and 5.7±1, respectively). Placental efficiency varied widely at each day (1.0 to 4.1, 2.1 to 6.2 and 4.1 to 7.5 for days 70, 90 and 110, respectively). On day 90, ASCT-1 was found to be more highly expressed in the endometrium associated with fetoplacental units having a higher placental efficiency ( $r = .35$ ,  $P = .05$ ). On day 110, individual fetoplacental units having a lower placental efficiency tended to have a higher endometrial mRNA expression

rBAT-1 and FAT-1 ( $r=-.65$ ,  $P=.08$ ;  $r=-.70$ ,  $P=.02$ , respectively). Variation in placental efficiency, while not completely defined, appears to be more influenced by expression of nutrient transporters in the adjacent endometrium.

**Key Words:** placental efficiency, nutrient transport, pig

**94 Energy determination of corn co-products fed to finishing pigs and use of in vitro OM digestibility to predict in vivo ME.** P. V. Anderson<sup>\*1</sup>, B. J. Kerr<sup>2</sup>, and G. C. Shurson<sup>3</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>USDA-ARS Swine Odor and Manure Management Research Unit, Ames, IA, <sup>3</sup>University of Minnesota, St. Paul.

Twenty co-products from various ethanol plants were fed to finishing pigs to determine ME and to generate an equation to predict ME based upon each ingredient's chemical analysis. Additionally, a 3-step enzymatic assay was used to determine if in vitro OM digestibility would predict in vivo ME or improve the prediction estimate of ME for corn co-products. Co-products included: DDGS (7), HP-DDG (3), bran (2), germ (2), gluten meal and feed, dehulled degermed corn, dried solubles, starch, and corn oil. The in vitro OM digestibility for each co-product was determined in triplicate using procedures as described by Boisen

and Fernandez (1997). For the in vivo study, the control diet was based on corn (97.1%), limestone, salt, vitamins, and trace minerals. All but two test diets were formulated by mixing the control diet with 30% of a co-product. Dried solubles and oil were included at 20% and 10%, respectively. Eight groups of 24 gilts ( $n=192$ , 112.7 final BW  $\pm$  7.9 kg) were randomly assigned to a test diet and each diet was fed to a total of 8 pigs. Gilts were placed in metabolism crates and fed an amount equivalent to 3% BW daily for 9 d followed by collecting feces and urine separately for 4 d. Ingredients were analyzed for GE, CP, moisture, crude fat, crude fiber, ash, total dietary fiber (TDF), NDF, and ADF. Gross energy was determined on the feed, feces, and urine to calculate ME for each ingredient. The in vitro OM digestibility ranged from 33.3 to 93.5% for corn bran and dried solubles, while ME ranged from 2,334 to 8,755 kcal/kg for corn gluten feed and corn oil, respectively. Although in vitro OM digestibility was correlated to in vivo ME ( $r = 0.62$ ,  $P < 0.01$ ), it did not improve the prediction of ME from ingredient analysis. Stepwise regression resulted in the equation: ME, kcal/kg =  $(0.949 \times GE) - (32.238 \times TDF) - (40.175 \times \text{ash})$  ( $r^2 = 0.95$ , SE = 306,  $P < 0.01$ ). These results indicate that OM digestibility and ME vary substantially between corn co-products and the best predictors of ME are GE, TDF, and ash.

**Key Words:** pigs, corn co-products, ME

## Graduate Student Competitive Research Papers, Ph.D. Oral Division

**95 Effects of nutritional plane and selenium supply on intestinal mass and mRNA expression of angiogenic factors and their receptors in the ewe and neonatal lamb.** A. M. Meyer<sup>\*1</sup>, T. L. Neville<sup>1</sup>, J. J. Reed<sup>1</sup>, J. B. Taylor<sup>2</sup>, L. P. Reynolds<sup>1</sup>, D. A. Redmer<sup>1</sup>, K. A. Vonnahme<sup>1</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

Objectives were to investigate effects of maternal nutrition and Se supply during gestation on ewe and lamb intestinal mass and mRNA expression of vascular growth-promoting factors and receptors. Rambouillet ewe lambs ( $n = 84$ ) were allocated to a  $2 \times 3$  factorial design including dietary factors of Se (adequate Se [ASe, 8.5  $\mu\text{g}/\text{kg}$  BW] or high Se [HSe, 80  $\mu\text{g}/\text{kg}$  BW]) and nutritional plane (60% [RES], 100% [CON], or 140% [HIGH]). At parturition lambs were removed and artificially reared, and 42 ewes (7/treatment) were necropsied. Remaining ewes were transitioned to common lactational diets and necropsied with all lambs on d 20. Jejunal mucosal scrapes were analyzed using quantitative real-time RT-PCR for mRNA expression of vascular endothelial growth factor (VEGF), VEGF Receptor-1 (FLT), VEGF Receptor-2 (KDR), endothelial nitric oxide synthase (eNOS), and soluble guanylate cyclase (sGC [NO receptor]). Interactions were present ( $P \leq 0.09$ ) for ewe VEGF and eNOS (nutrition  $\times$  Se  $\times$  necropsy period [Pd]), FLT (Se  $\times$  Pd, nutrition  $\times$  Pd), and small intestinal mass (Se  $\times$  Pd, nutrition  $\times$  Pd). At parturition small intestinal mass (g) was greater ( $P \leq 0.02$ ) for HIGH fed ewes than RES and CON and was decreased ( $P < 0.01$ ) by HSe. Ewes fed ASe-HIGH had greater ( $P < 0.02$ ) jejunal mucosal VEGF and eNOS mRNA than ASe-CON and HSe-HIGH at lambing. In addition, at parturition CON ewes had less ( $P \leq 0.08$ ) mucosal FLT mRNA compared with RES and HIGH, whereas ASe ewes had greater ( $P \leq 0.006$ ) FLT than HSe. Ewes fed HIGH had greater ( $P = 0.04$ ) mucosal KDR mRNA compared with RES. Ewe mucosal sGC mRNA declined ( $P \leq 0.06$ ) from parturition to d 20 lactation. There was no effect of maternal treatment on lamb small intestinal mass, but a Se  $\times$  nutrition interaction ( $P \leq 0.07$ ) indicated that lambs from ewes fed ASe-HIGH had increased ( $P \leq 0.03$ ) jejunal mucosal sGC mRNA compared with

ASe-RES and HSe-HIGH, whereas lambs from ASe-CON ewes had greater ( $P < 0.08$ ) sGC than HSe-CON. These data indicate that maternal and offspring intestinal VEGF and eNOS systems are responsive to maternal nutritional plane and Se supply.

**Key Words:** angiogenesis, intestine, nutrition

**96 Effect of dietary arginine supplementation to sows on litter size, fetal weight and myogenesis at d 75 of gestation.** J. Bérard<sup>\*1,2</sup>, M. Kreuzer<sup>2</sup>, and G. Bee<sup>1</sup>, <sup>1</sup>Agroscope Liebefeld Posieux, Posieux, Fribourg, Switzerland, <sup>2</sup>Department of Agricultural and Food Science, Zurich, Zurich, Switzerland.

Arginine level is known to be elevated in porcine amniotic and allantoic fluid during early pregnancy suggesting that it plays an important role in embryonic, placental and fetal development. Thus, the aim of the study was to determine the effect of dietary arginine supplementation to primiparous gilts on litter size, fetal weight (FW) and myogenesis at d 75 of gestation. At the day of mating 20 Swiss Large White gilts were randomly allocated to either control (C) or the arginine treatment (A). All gilts were offered daily 3 kg of a standard diet from mating to d 75 of gestation. Additionally, A-sows received from d 14 to 28 daily 25 g L-arginine. Because of non-pregnancy 3 C-gilts were excluded from the trial. At d 75 of gestation all sows were sacrificed and all fetuses counted and weighed. From each litter the lightest, heaviest, and the ones with an average FW from both genders were selected and the semitendinosus (ST) muscles were excised. The cross-sectional area of the ST and the number of primary (P) and secondary fibers (S) and the S/P ratio were determined. In A-sows litter size was greater (13.0 vs. 9.3;  $P = 0.04$ ) than in C-sows whereas FW did not ( $P = 0.95$ ) differ. The ST of A-sows fetuses had more P (17699 vs. 16477;  $P < 0.04$ ) and the S/P ratio was lower (20.3 vs. 21.5;  $P < 0.07$ ) than in fetuses from C-sows. Regardless of treatment, the cross-sectional area of the ST was larger (28.4 vs. 23.7 mm<sup>2</sup>;  $P < 0.01$ ) and the total number of S (384389

vs. 340471), the S/P fiber ratio (21.6 vs. 19.5) and the total fiber number were greater (401975 vs. 357193;  $P < 0.05$ ) in fetuses with a high compared to a medium or low FW. Neither ovulation rate (yellow body count) nor the number of mummies differed among treatments, which implies that dietary arginine supplementation during early gestation improved embryo implantation rate without negatively affecting FW. The greater number of P in the ST of fetuses from A-sows suggest that total fiber number at birth might be positively affected by L-arginine since hyperplasia of P is terminated at d 55 of gestation and P serve as scaffold for subsequent S formation.

**Key Words:** gestation, myogenesis, pig

**97 Sequence diversity in shrimp species and how to exploit it.** D. M. Gorbach\*, Z.-L. Hu, Z.-Q. Du, and M. F. Rothschild, *Iowa State University, Ames.*

Shrimp farming is a huge industry worldwide but is lagging behind the other livestock industries in terms of genetic research. The first step in the creation of a shrimp linkage map is to discover SNP markers that are segregating within a species. Having already mined the *Litopenaeus vannamei* (Pacific White Shrimp) EST resources for potential SNPs, we turned to other shrimp species for comparative genomic information. Publicly available expressed sequence tags (ESTs) were collected from NCBI for clustering and comparison from the following shrimp species: *Artemia franciscana*, *Fenneropenaeus chinensis*, *F. indicus*, *F. merguensis*, *L. setiferus*, *L. stylirostris*, *Marsupenaeus japonicus*, *Palaemonetes pugio*, and *Penaeus monodon*. Most of these species are penaeid shrimp, and thus closely related to *L. vannamei*. Clustering was completed with CAP3, followed by the detection of sequence differences using SNPIdentifier software. Sequence differences came in three main varieties: 1) the base was segregating within one or more species, 2) the base only varied between species, or 3) the base varied both within and between species. The observed counts were: 3571 positions of type 1; 703 of type 2; 323 of type 3. The within species SNPs were most abundant due to the high frequency of *A. franciscana* sequences, which never clustered with other species. Meanwhile, 735 bases (all 703 of type 2 and 32 of type 3) may prove useful for differentiating species genetically. Bases segregating within species (types 1 and 3) were used to predict SNPs in *L. vannamei*, the most commonly farmed species of shrimp. Out of 9 SNPs in 5 contigs sequenced that were predicted to segregate in *L. vannamei*, 1 SNP was observed to vary amongst the 16 animals tested. These results suggest this method is not likely to generate many new SNPs for mapping of Pacific White Shrimp.

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**Key Words:** shrimp, ESTs, SNPs

**99 The effect of supplementing dried distillers grains to steers grazing cool season meadow.** W. A. Griffin\*<sup>1</sup>, B. L. Nuttleman<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, G. E. Erickson<sup>1</sup>, L. A. Stalker<sup>2</sup>, J. A. Musgrave<sup>2</sup>, and R. N. Funston<sup>2</sup>, <sup>1</sup>*University of Nebraska, Lincoln*, <sup>2</sup>*West Central Research and Extension Center, North Platte, NE.*

In two summers, 24 (BW = 286 ± 21.4 kg; Exp. 1) and 48 (BW = 276 ± 21 kg; Exp. 2) spring born steers were used to determine the effect of supplementing dried distillers grains plus solubles (30.4% CP, and 11.2% EE; DDGS) to steers grazing subirrigated Sandhills meadow (cool season grass dominated; 52.9% TDN, 64.4% NDF, and 13.0% CP). At study initiation and conclusion for Exp. 1 and 2, steers were limit fed

2% of BW and weighed three consecutive d to determine initial and final BW. Steers were then stratified by BW and assigned randomly to treatment. In Exp. 1, there were 2 treatments: steers grazing with no supplementation or supplemented DDGS at 0.5% of BW (1.3 kg) daily. In Exp. 2, there were 3 treatments: steers grazing with no, low (0.5% of BW; 1.3 kg), or high (1.0% of BW; 2.7 kg) DDGS supplementation daily. In both Exp. 1 and 2, steers were individually supplemented for the duration of the study; 92 d and 91 d, respectively. Both experiments were analyzed as completely randomized designs with individual steer as the experimental unit. In Exp.1, initial BW ( $P = 0.94$ ) and final BW ( $P = 0.52$ ) were not different, however; final BW was numerically heavier (6 kg) for supplemented steers and ADG ( $P = 0.16$ ) was 0.92 and 0.87 kg/d for supplemented and unsupplemented steers, respectively. In Exp. 2, initial BW was not different across treatment ( $P = 0.91$ ). However, ADG ( $P < 0.01$ ) and final BW ( $P = 0.02$ ) were greater with DDGS supplementation. Linear increases were observed in ADG (0.88 vs. 1.01 vs. 1.17;  $P < 0.01$ ) and final BW (354 vs. 370 vs. 380;  $P < 0.01$ ) as level of DDGS supplementation increased from 0.0 to 1.0% of BW. In Exp.1, supplementing DDGS at 0.5% of BW did not affect steer gain and BW. However, in Exp. 2, supplementing DDGS to grazing steers increased final BW and ADG linearly with increasing level of DDGS supplementation.

**Key Words:** dried distillers grains plus solubles, summer grazing, supplementation

## 100 WITHDRAWN.

**101 Effects of mannan oligosaccharide on immune response and growth performance in weaned pigs experimentally infected with PRRS virus.** M. T. Che\*<sup>1</sup>, R. W. Johnson<sup>1</sup>, K. W. Kelley<sup>1</sup>, W. G. Van Alstine<sup>2</sup>, K. A. Dawson<sup>3</sup>, C. A. Moran<sup>3</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*Purdue University, West Lafayette, IN*, <sup>3</sup>*Alltech North American Bioscience Center, Nicholasville, KY.*

The study was conducted to determine whether feeding a mannan oligosaccharide preparation (MOS, Bio-Mos<sup>®</sup>) alters the weaned pig's immune response to a porcine respiratory and reproductive syndrome virus (PRRSV) challenge. Pigs (3-wk old, n=64), free of PRRSV, were divided into blocks of 4 pigs based on litter origin, BW, and gender. They were randomly assigned to one of 4 treatments (0% or 0.2% MOS × with or without PRRSV). There were 8 replicate chambers of 2 pigs each. Pigs fed control or MOS diets for 2 wk were intranasally inoculated with PRRSV or medium at 5 wk of age. PRRSV challenge decreased ( $P < 0.01$ ) growth performance, increased ( $P < 0.01$ ) inflammatory mediators and rectal temperature, and affected differential leukocyte counts. In contrast, MOS improved G:F of pigs ( $P < 0.05$ ) during 7 to 14 d post-inoculation (DPI). MOS was associated with rapidly increased numbers of white blood cells, neutrophils, and lymphocytes at 3 and 7 DPI ( $P < 0.05$ ) (Table 1). The MOS × PRRSV interaction was significant for rectal temperature at 7 DPI ( $P < 0.01$ ) and TNF- $\alpha$  at 14 DPI ( $P = 0.06$ ), as MOS reduced the rectal temperature and serum TNF- $\alpha$  in infected pigs only. These results suggest that MOS causes the pigs to quickly respond to a viral challenge at the early stage of infection and alleviates PRRSV-induced effects on G:F and fever.

**Table 1. Differential leukocyte counts of weaned pigs fed control or MOS diet with and without PRRSV<sup>a</sup>**

Item, x 10 <sup>3</sup> /μL	Control	MOS	PRRSV	MOS+ PRRSV	SEM
<b>3 DPI</b>					
White blood cells <sup>bc</sup>	10.76	12.71	7.66	10.16	1.08
Neutrophils	3.29	3.44	3.41	5.41*	0.70
Lymphocytes <sup>b</sup>	6.71	8.61	3.92	4.29	0.68
<b>7 DPI</b>					
White blood cells <sup>bc</sup>	12.79	14.18	9.74	11.92	0.82
Neutrophils <sup>b</sup>	3.58	3.18	4.08	5.01	0.50
Lymphocytes <sup>bc</sup>	8.46	10.20	4.90	6.13	0.60

<sup>a</sup>Means (n=16). <sup>b</sup>Effect of PRRSV ( $P<0.05$ ). <sup>c</sup>Effect of diet ( $P<0.05$ ).  
\*Different from control and PRRSV ( $P<0.05$ ).

**Key Words:** immune response & PRRSV, mannan oligosaccharide, weaned pigs

**102 Effects of growing diet composition on abundance of peroxisome proliferator-activated receptor gamma-2 in beef cattle adipose tissue.** J. S. Jennings\*, J. A. Clapper, A. D. Weaver, and A. E. Wertz-Lutz, *South Dakota State University, Brookings.*

We hypothesized that peroxisome proliferator-activated receptor gamma-2 (PPAR $\gamma$ 2) abundance would be increased in subcutaneous adipose tissue of beef cattle consuming a high concentrate compared with a high forage diet during the growing phase. Beef steers (n=72) of similar weight (292±1.44 kg) were used to determine the effects of growing diet on PPAR $\gamma$ 2 abundance in subcutaneous adipose tissue. At trial initiation, 8 steers were harvested for initial adipose tissue collection. The remaining 64 steers were allotted, by weight, to pen, and treatment was assigned randomly. Treatments were 1) 60% forage; 40% concentrate diet fed during the growing period (112 d) followed by 10% forage; 90% concentrate diet during the finishing period (113-209 d) (GRW-FNSH) or 2) 10% forage; 90% concentrate diet fed for the duration of the experiment (0-209 d) (FNSH-FNSH). Steers were allowed ad libitum consumption. Eight steers per treatment were harvested on d 88, 116, 165, and 209. Subcutaneous adipose tissue samples were collected from each steer and immediately immersed in liquid nitrogen. Protein separation and quantification was performed using SDS-PAGE and Western blotting techniques with a PPAR $\gamma$ 2 isoform-specific antibody. Abundance of PPAR $\gamma$ 2 was quantified using the LI-COR<sup>®</sup> system and normalized to  $\beta$ -Actin. Protein abundance data were analyzed statistically using the MIXED procedure of SAS comparing diet, harvest date, and their interaction. Linear, quadratic, and cubic contrasts also were performed. Dietary treatment altered growth performance, however, it did not affect ( $P=0.61$ ) PPAR $\gamma$ 2 abundance. Abundance of PPAR $\gamma$ 2, regardless of treatment, decrease linearly ( $P\leq 0.05$ ) over time. These data do not support the hypothesis that PPAR $\gamma$ 2 abundance is increased in growing cattle consuming a high concentrate diet. However, decreased PPAR $\gamma$ 2 abundance with cattle age warrants further investigation.

**Key Words:** PPAR $\gamma$ 2, beef adipose tissue

**103 Feedlot performance and carcass characteristics of steers and heifers whose dams were nutrient restricted from early to mid-gestation.** P. L. Price\*, V. Nayigihugu, M. Du, W. J. Means, S. I. Paisley, and B. W. Hess, *University of Wyoming, Laramie.*

Eighteen steers and 18 heifers, born to cows that were individually fed native grass hay plus 1 of 3 supplements from d 45 through d 185

of gestation were evaluated for effects of maternal gestational dietary treatment on feedlot performance and carcass characteristics. Maternal dietary treatments consisted of native grass hay plus a soybean meal-based supplement (C), 70% of C dietary NE<sub>m</sub> (NR), and 70% of C dietary NE<sub>m</sub> plus a ruminally undegradable protein (RUP) supplement designed to provide metabolizable essential AA equal to that of cattle fed C (NRP). Cows were managed together after the restriction period. Following weaning and a 14 d background period, calves were placed in a feedlot and fed a similar diet until slaughter. Data were analyzed as a 3 × 2 factorial design, with treatment factors being maternal dietary treatment and calf sex. During the finishing phase, ADG (1.34 ± 0.07 kg/d) did not differ ( $P = 0.51$ ) among dietary treatments; whereas, average daily feed intake tended to be greater ( $P = 0.06$ ) for calves born to NR (13.1 kg/d) cows than calves born to C (11.8 kg/d) cows with calves born to NRP (12.3 kg/d) cows being intermediate. During this phase calves born to NR cows had a positive residual feed intake, which was greater ( $P = 0.02$ ) than the negative values noted for calves born to C cows with calves born to NRP cows being intermediate; however, G:F did not differ ( $P = 0.49$ ) among treatments. As a percentage of HCW, KPH was greater ( $P = 0.03$ ) for calves born to C cows than calves born to NRP cows with calves born to NR cows being intermediate. Live BW at slaughter ( $P = 0.88$ ), HCW ( $P = 0.99$ ), LM area ( $P = 0.63$ ), yield grade ( $P = 0.34$ ), marbling score ( $P = 0.22$ ), 12th rib fat thickness ( $P = 0.35$ ), and small intestinal length ( $P = 0.95$ ) and weight ( $P = 0.15$ ) did not differ among treatments. Although early to mid-gestational nutrient restriction of cows demonstrated minimal effects on carcass characteristics of progeny, calves born to nutrient restricted cows tended to consume more feed during the finishing phase.

**Key Words:** gestational nutrition, feedlot performance, carcass characteristics

**104 Effect of selection for residual feed intake on feeding behavior in pigs.** J. M. Young\*, W. Cai, and J. C. M. Dekkers, *Iowa State University, Ames.*

Residual feed intake (RFI) is a measure of feed efficiency defined as the difference between observed and predicted feed intake based on average requirements for growth and maintenance. The objective of this study was to evaluate the effect of selection for lower RFI on feeding behavior traits (FBT) and to estimate the relationship between FBT and RFI. Data were from gilts from the 4th generation of a selection experiment for lower RFI (LRFI) and a randomly selected control line (CTRL). Lines were mixed in pens of 16 and evaluated for FBT obtained from a single-space electronic feeder (FIRE<sup>®</sup>) over a growing period of ~3 months prior to 115 kg. The following FBT were evaluated over the entire test period (TP) and over the first (TP1) and second half (TP2) of the test period: average number of visits per day (NVD), average occupation time per day (OTD) and per visit (OTV), average feed intake per day (DFI) and per visit (FIV), and average feeding rate per visit (FRV). LRFI pigs ate 8.0, 6.0, and 9.2% less than CTRL pigs for TP, TP1, and TP2 ( $P=0.01, 0.048, 0.01$ ). LRFI pigs also spent ~14.0% less time in the feeder per day than CTRL pigs regardless of time period ( $P=0.03, 0.03, 0.04$ ) and ate 14.8, 15.5, and 16.3% faster while in the feeder for TP, TP1, and TP2 ( $P=0.045, 0.02, 0.052$ ). LRFI pigs tended to visit the feeder ~7% fewer times per day but this was not significant ( $P=0.28, 0.41, 0.11$  for TP, TP1, and TP2). FIV and OTV did not differ between lines in any test period. Across lines, OTD was significantly correlated with RFI (0.21, 0.22, and 0.19 for TP, TP1, and TP2), as was NVD (0.17, 0.14 and 0.15 for TP, TP1, and TP2). Other traits were not correlated with RFI. In conclusion, selection for LRFI has resulted in pigs which eat faster, spend less time eating,

and eat fewer times per day. Future analyses will evaluate correlations between RFI and FBT within line and differences in patterns of feed consumption during the day. Funding provided by the National Pork

Board, the Iowa Pork Producers Association, and National Needs Fellowship grant no. 2007-38420-17767.

**Key Words:** pigs, feeding behavior, residual feed intake

## Graduate Student Competitive Research Papers, M.S. Poster Division

### 105 WITHDRAWN.

#### 106 Effects of high-sulfur water and clinoptilolite on growth performance and gene expression of steers fed forage-based diets.

K. L. Kessler<sup>\*1</sup>, K. C. Olson<sup>2</sup>, C. L. Wright<sup>2</sup>, K. J. Austin<sup>1</sup>, P. S. Johnson<sup>2</sup>, and K. M. Cammack<sup>1</sup>, <sup>1</sup>University of Wyoming, Laramie, <sup>2</sup>South Dakota State University, Brookings.

Sulfur-induced polioencephalomalacia (PEM), a neurological disorder affecting ruminants, is frequently associated with consumption of high-S water. Identification of a feed supplement that would counteract the negative effects of high-S water would decrease the incidence of S-induced PEM in regions with problematic water sources. The objectives of this study were to 1) determine the effects on performance and gene expression in steers administered high-S water, and 2) determine if clinoptilolite, a clay mineral high in cation-exchange capacity, ameliorates the effects of high-S water consumption. Yearling steers ( $n = 96$ ;  $318.2 \pm 2.1$  kg BW) were randomly assigned to 1 of 4 treatments for a 77 d trial period: low-S water control ( $566$  mg  $\text{kg}^{-1}$  sulfate), high-S water ( $3,651$  mg  $\text{kg}^{-1}$  sulfate), or high-S water plus clinoptilolite supplemented at either 2.5% or 5.0% of diet DM. Feed and water consumption were measured daily, and all steers were weighed d -2, -1, 29, 53, 76, and 77. Plasma and liver samples were collected prior to and at the conclusion of the trial. Morbidity and mortality were higher ( $P = 0.0014$ ) for steers receiving high-S water; however, no differences in animal health were observed among clinoptilolite levels. Dry matter intake was lower ( $P = 0.074$ ) for steers consuming high-S water regardless of level of clinoptilolite. No differences in ADG or feed efficiency were observed. Plasma chemistry analyses showed lower protein ( $P = 0.041$ ) and higher urea N ( $P = 0.050$ ) in high-S water steers at the conclusion of the trial. Mineral analyses showed an interaction ( $P < 0.05$ ) of sample time and treatment in hepatic Cu and Se concentrations. Microarray analyses of selected low-S water and high-S water (0% clinoptilolite) steers revealed differential expression of immune response, cell to cell recognition, and cell surface receptor genes. These results suggest that clinoptilolite does not negate the effects of high-S water, and administration of high-S water decreases herd health, possibly through altered immune function.

**Key Words:** sulfur, polioencephalomalacia, gene expression

#### 107 Working chute behavior of feedlot cattle can be an indication of cattle temperament and beef carcass composition and quality.

N. L. Hall<sup>\*</sup>, V. L. Anderson, K. R. Carlin, J. C. Galbreath, and E. P. Berg, North Dakota State University, Fargo.

The influence of temperament on beef carcass quality traits was measured on 180 mixed composition Bos Taurus steers. Steers ( $n = 183$ ) were sorted into 16 different pens based on initial weight (280 kg). Steers were weighed every 28 d with data recorded for temperament as exit velocity (EV), chute score (CS), catch score (CAPS), and chute vibration (VIB). Tissue samples were collected for the commercial DNA profile by IGENITY including docility. Steers were harvested at 14 to 16 mo of age (605 kg). Measurements of hot carcass weight, ribeye area, 12th rib fat (12FD), percentage fat, kidney, pelvic, heart fat (KPH), intramuscular

fat (MARB), and USDA yield grade (YG) were taken 24h postmortem. Measurements for pH (45 min and 36h) and color scores ( $L^*$ ,  $a^*$ , and  $b^*$ ) were taken. Longissimus thoracis samples were collected and aged 14 d before Warner-Bratzler shear (WBS) force was determined. Exit velocity increased and CS, and CAPS values declined over time indicating that animals acclimated to the working chute environment. First EV had significant ( $P < 0.05$ ) correlations with WBS ( $r = -0.19$ ) and last EV with YG ( $r = 0.19$ ), 12FD ( $r = 0.15$ ), KPH ( $r = 0.19$ ), and MARB ( $r = 0.15$ ). First CAPS significantly ( $P < 0.05$ ) correlated with DRESS ( $r = 0.16$ ), 36h pH ( $r = 0.30$ ), and  $L^*$  ( $r = -0.20$ ), last CAPS with YG ( $r = -0.17$ ), final BW ( $r = -0.15$ ), and pH36H ( $r = 0.19$ ), and average CAPS with YG ( $r = 0.17$ ), MARB ( $r = -0.20$ ) and 36h pH ( $r = 0.20$ ). Steers receiving a CAPS of 1 or 2 possessed more marbling (small) than steers with CAPS of 4 (slight). Ribeye steaks from steers with a slow first EV ( $> 1.0$  sec) were more tender (3.37 kg) than steaks from fast ( $< 0.70$  sec) and moderate (0.71 to 0.99 sec) EV steers (3.90 and 3.82 kg, respectively). However, steers with moderate to high genetic potential for docility (Igenity docility index) had tougher WBS (3.92 and 4.28 kg, respectively) than steers with low docility index (3.52 kg). These data indicate that behavior in the working chute environment may be an appropriate indicator of cattle temperament which may have a negative influence on beef palatability.

**Key Words:** beef, temperament, exit velocity

#### 108 Validation of a rapid analytical technique to predict oxidation capacity of fresh beef.

L. Senaratne<sup>\*</sup>, C. Calkins, T. Carr, and A. S. de Mello Jr., University of Nebraska, Lincoln.

Lipid oxidation is a major source of fresh beef color deterioration. Typically, oxidation of meat has been indicated by development of thiobabutaric acid reactive substances – TBARS – which arise post-oxidation. A rapid technique was developed to measure the capacity for oxidation of fresh beef by inducing the formation of conjugated diene hydroperoxides from oxidation of polyunsaturated fatty acids (PUFA). Amount of conjugated dienes are measured after catalyzing oxidation in a muscle extract by copper at 37°C and pH 7.4 for 20 min. The purpose of this study was to validate the methodology in samples of beef m. *semitendinosus* (eye of round steak) under various display conditions. Total oxidation capacity (with the new technique) and level of oxidation (using TBARS) were determined for three different treatments (ground in oxygen-permeable retail overwrap, whole muscle in retail overwrap and vacuum-packaged whole muscle). Measures were obtained after 0, 3, 7, 14, and 21 d of cold storage. Oxidation capacity reduced gradually ( $P < 0.001$ ) in all treatments during cold storage, indicating that oxidation occurred. Ordering the treatments, the greatest reduction in oxidation capacity was for ground-overwrap, whole-overwrap and then vacuum-packaged beef, respectively ( $P < 0.05$ ). The TBARS of ground and whole beef in retail overwrap increased ( $P \leq 0.05$ ) with time of cold storage whereas TBARS of vacuum-packaged beef did not significantly change. The TBARS values after storage were highest for ground beef and lowest for vacuum-packaged beef ( $P \leq 0.05$ ). Therefore, there were significant negative linear relationships between oxidation capacity and TBARS in ground ( $r = -0.62$ ,  $P = 0.014$ ) and whole ( $r = -0.70$ ,  $P = 0.002$ ) beef in retail overwrap across the cold storage period. Therefore, the

oxidation capacity of beef decreases during cold storage and the reduction in oxidation capacity is concomitant with an increase in TBARS. Thus, this method of measuring oxidation capacity provides useful information without having to wait for oxidation to occur.

**Key Words:** beef, conjugated dienes, oxidation

**109 Effects of low-solubles distiller's dried grains (LS-DDG) in diets for growing-finishing pigs: Carcass characteristics and pork fat quality.** R. B. Amaral<sup>1</sup>, L. J. Johnston<sup>2</sup>, J. E. Anderson<sup>3</sup>, S. K. Baidoo<sup>4</sup>, and G. C. Shurson<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>West Central Research and Outreach Center, Morris, <sup>3</sup>University of Minnesota, Morris, <sup>4</sup>Southern Research and Outreach Center, Waseca.

This study was conducted to assess the effects of LS-DDG on carcass characteristics and pork fat quality when fed to growing-finishing pigs. Pigs (n = 216; 18.8 ± 0.76 kg initial BW) were blocked by weight and pens were assigned randomly to one of three dietary treatments in a 4-phase feeding program (24 pens, 9 pigs/pen). Diets were formulated on a SID amino acid basis following NRC (1998) nutrient requirements for pigs gaining 350 g/d of lean tissue. Diets included a corn-soybean meal control (C); C containing 20% LS-DDG (L); and C containing 20% distiller's dried grains with solubles (D). Crude fat content of LS-DDG (7.95%) was lower than typical distiller's dried grains with solubles (8.87%). Hot carcass weight did not differ among treatments but dressing percentage was lower (P < 0.01) for pigs fed L and D compared to C (C = 73.8%; L = 72.8%; D = 72.8%; SEM = 0.22). Pigs fed L displayed reduced (P = 0.02) 10th-rib backfat depth (C = 15.5 mm; L = 14.2 mm; D = 16.0 mm; SEM = 0.47) and increased (P = 0.02) carcass lean (C = 54.1%; L = 54.8%; D = 53.4%; SEM = 0.33) compared to pigs fed D, but similar to pigs fed C. The belly flop test revealed that bellies from pigs fed D were softer (P < 0.01) than those from pigs fed C (C = 17.7°; L = 14.1°; D = 12.9°; SEM = 1.07). However, only a tendency (P = 0.07) for softer bellies was observed when pigs received L compared to C. The PUFA content of belly fat was reduced (P < 0.01) by L compared with D but was still elevated compared to pigs fed C (C = 9.4%; L = 14.0%; D = 15.4%; SEM = 0.34). Thus, pigs fed L tended (P = 0.06) to have lower iodine value of belly fat compared to pigs fed D (C = 57.8; L = 63.1; D = 65.0; SEM = 0.53). Gilts fed L had lower (P = 0.02) PUFA (13.4%) in belly fat than gilts fed D (15.9%) while there was no difference among barrows (L = 14.6%; D = 15.0%, SEM = 0.50). In summary, inclusion of 20% LS-DDG in diets for growing-finishing swine can lessen the negative impacts of DDGS on pork fat quality; and pork fat of gilts may be more sensitive to dietary LS-DDG than that of barrows.

**Key Words:** carcass, fat quality, low-solubles distiller's dried grains

**110 Effects of crude glycerol and ractopamine HCl on growth performance, carcass characteristics, and loin quality of finishing pigs.** A. W. Duttlinger<sup>1</sup>, J. M. DeRouche<sup>1</sup>, M. D. Tokach<sup>1</sup>, S. S. Dritz<sup>1</sup>, J. L. Nelssen<sup>1</sup>, R. D. Goodband<sup>1</sup>, T. A. Houser<sup>1</sup>, K. J. Prusa<sup>2</sup>, and L. Huskey<sup>3</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Iowa State University, Ames, <sup>3</sup>JBS Swift & Company, Greeley, CO.

A total of 1,054 pigs (94.3 kg BW) were used in a 28-d study. Pigs were blocked by BW and randomly allotted to 1 of 4 dietary treatments with 10 pens per treatment. Treatments were arranged in a 2x2 factorial with main effects of glycerol (0 or 5%) and ractopamine HCl (RAC; 0 or 7.5 ppm) added to corn-soybean meal-based diets. There were no glycerol × RAC interactions (P > 0.16) for growth performance. Glycerol tended to improve (P < 0.07) G:F, but did not influence (P > 0.36) ADG

or ADFI. Feeding RAC increased (P < 0.01) ADG and G:F. For carcass characteristics, there were glycerol × RAC interactions (P < 0.05) for percent yield. Adding either RAC or glycerol to the diet increased yield; however, the effects were not additive. Pigs fed RAC had increased (P < 0.04) hot carcass weight, yield, loin depth, and FFLI. Loin chop drip loss worsened when glycerol and RAC were added separately to the diet; however, drip loss decreased when the combination of glycerol and RAC were fed (interaction P < 0.01). Glycerol did not affect (P > 0.22) loin characteristics. Feeding RAC tended to improve (P < 0.08) sirloin chop a\* color. Neither RAC nor glycerol influenced (P > 0.17) iodine value of belly, jowl, or back fat. In conclusion, feeding pigs 5% glycerol improved G:F, while pigs fed RAC had improved growth and carcass characteristics and a tendency for improved a\* color.

**Table 1.**

Item	RAC, ppm		0		7.5		SE
	Glycerol, %		0	5	0	5	
ADG, kg	0.88	0.88	0.98	0.99	0.92		
G:F	0.30	0.30	0.34	0.35	0.01		
Carcass wt, kg	85.9	87.1	90.5	89.8	0.94		
Yield, %	74.63	75.85	76.26	75.91	0.37		
Backfat, mm	17.95	17.65	16.92	17.58	0.34		
Loin depth, mm	57.68	58.64	61.28	61.46	1.01		
Lean, %	54.59	54.62	54.99	55.05	0.42		
Loin chop drip loss, %	1.89	2.61	2.47	2.03	0.18		
Iodine value, g/100 g							
Jowl fat	69.6	68.9	69.7	70.7	0.70		
Belly fat	68.6	70.0	69.6	69.7	1.49		
Backfat	69.0	67.8	67.8	68.3	0.70		

**Key Words:** glycerol, finishing pig, ractopamine HCL

**111 Effects of distillers grain supplementation on dystocia and beef cow performance.** J. M. Carmack<sup>1</sup>, P. M. Walker<sup>1</sup>, R. L. Atkinson<sup>2</sup>, K. L. Jones<sup>2</sup>, and S. W. Reader<sup>2</sup>, <sup>1</sup>Illinois State University, Normal, <sup>2</sup>Southern Illinois University, Carbondale.

Little information has been reported regarding high dietary inclusion levels of high moisture corn distillers grains with solubles (DGS) on beef cow performance. The objective of this 2 year study is to determine the optimum inclusion rate for DGS in late gestation and early lactation beef cow diets and the effect of including high dietary levels of DGS on dystocia, postpartum conception rate and other measures of performance. During year one, ninety-six multiparous cows and thirty-two, 2-yr old heifers at the start of the third trimester were assigned to 16 pens by BW and BCS, and fed for 163 d until a timed-A.I. Control cows were fed corn silage-shelled corn-soybean meal based diets (CNTL) to provide 12% CP. In treatment diets DGS replaced shelled corn and soybean meal to provide 12% (T1), 16% (T2) or 20% (T3) CP. Analyzed dietary values for CP intakes were 12.0, 12.5, 15.7 and 19.0 for CNTL, T1, T2 and T3, respectively. Mean ADFI was 18.8 kg ± 1.73, 19.4 kg ± 2.05, 20.0 kg ± 2.45 and 19.3 kg ± 2.04 for CNTL, T1, T2 and T3, respectively. Mean DMI was 9.4 kg ± 1.91, 9.4 kg ± 1.00, 10.3 kg ± 1.27 and 10.4 ± 1.11 for CNTL, T1, T2 and T3, respectively with DGS representing 21, 36 and 55% of DMI for T1, T2 and T3, respectively. No differences (P > 0.05) between treatments were observed for cow BW, BCS, conception rate, calving ease score and calf BW. Calf weight at A.I. was greater for T2 than T1 (P < 0.05). Conception rates to a timed-A.I. were higher (P < 0.05) for T1 than T2. No differences (P > 0.05) between treatments were observed, except percent bred tended higher (P < 0.08) for T3 (93%) than CNTL, T1 or T2 (mean = 88%). Milk production was higher (P <

0.05) for T2 than CNTL, T1 or T2. The data of year one (year two is in progress) suggest that late gestation and early lactation diets containing up to 55% DGS (DM basis) can be successfully fed without decreased performance.

**Key Words:** distillers grains, high dietary levels, beef cows

**112 Effects of crude glycerin on feedlot performance and carcass characteristics of finishing wether lambs.** P. Gunn<sup>\*1</sup>, M. Neary<sup>1</sup>, R. Lemenager<sup>1</sup>, and S. Lake<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>University of Wyoming, Laramie.

The objective of this study was to evaluate the effects of crude glycerin (90% pure) on performance and carcass characteristics in finishing wether lambs. Thirty black-faced Suffolk-cross wether lambs (44.1 ± 5.6 kg initial BW) were stratified and blocked by BW, and individually fed one of five isocaloric, isonitrogenous dietary treatments containing 0, 5, 10, 15, or 20% crude glycerin (90% glycerol) on a DM basis. Diets, which were fed once daily for ad libitum consumption, were primarily comprised of 15% chopped hay, 25% dried distiller's grains with solubles, and cracked corn, which was replaced with increasing levels of crude glycerin. Wethers were weighed on 14-d intervals and were selected for harvest when they reached a 12th rib fat depth of 0.51 cm (28 to 84 d on trial). Carcass characteristics were collected following a 24-h chill. There were no differences among treatments for final BW (P = 0.84) and days on feed (P = 0.64). However, DMI tended (P = 0.11) to increase linearly with increasing levels of glycerin. Lambs fed 0, 5, 10, 15 and 20% glycerin had ADG of 0.23, 0.20, 0.28, 0.30, and 0.24 kg, respectively (cubic, P = 0.06). Similarly, feeding glycerin had a cubic effect (P = 0.03) on G:F with lambs fed 15% glycerin tending (P = 0.15) to have greater G:F than lambs fed either 5 or 20% glycerin. Body wall thickness (P = 0.71), flank streaking (P = 0.43), and leg score (P = 0.26) did not differ between dietary treatments. Dressing percent (P = 0.03; cubic, P = 0.002), HCW (P = 0.14; cubic, P = 0.01), and LM area (P = 0.14; cubic, P = 0.03) measurements were optimal in wethers fed 5% glycerin and least in lambs fed 15% glycerin. Adding up to 15% crude glycerin to finishing wether diets improved feedlot performance; however, improvements in carcass traits were greatest when adding glycerin at levels of only 5% DM.

**Key Words:** dried distiller's grains, crude glycerin, wethers

**113 High moisture distillers grains can be successfully stored during summer.** A. R. Hanson\*, P. M. Walker, and J. M. Carmack, *Illinois State University, Normal.*

Low cost, efficient methods for storage of high moisture corn distillers grains with solubles (DGS) are needed. The objective of this study was to evaluate and compare two methods for storing DGS in bunker silos from May to August on preservation quality and nutrient composition. Two bunker silos with concrete walls and floors were filled with either 170 mt (metric tons) or 208 mt of DGS. The DGS in one bunker was topped with 682 kg of granular salt (517.6 g salt/0.09m<sup>2</sup> surface area) and covered with a 24mm thick white plastic silo cover (T1). The DGS in a second bunker was covered with 16.32 mt of ground limestone (density=23.6g/16.4cc particle size=100% passage through a 1mm screen) to an approximate depth of 12.7cm (T2). Subsequent to application, the limestone was wetted with water and allowed to crust. Core samples of DGS were collected for analysis at filling (0d), 34d, and end of study (113d). Spoiled DGS was collected and weighed from each treatment. Spoilage was similar between treatments T1 and T2 comparing 6.1% to 5.9%, respectively. Samples were analyzed for N, P, Ca, Na, S, ADF, ADIN, acetic acid (Ac), propionic acid (Pr), butyric acid (Bu), lactic acid (LA), and pH.

Mean composition of DGS at 0d was 4.4±0.12% N, 0.91±0.05% P, 0.08±0.02% Ca, 0.67±0.09% Na, 0.60±0.1% S, 1.02±0.17% ADIN, 21.06±2.19% ADF, and pH of 3.95±0.04. No significant differences in nutrient content were observed for T1 between 0d and 113d of storage. For T2, ADIN increased (P<0.05) by 42.2% from 1.02±0.17% to 1.45±0.14%, pH increased 21.8% from 3.95 to 4.81, Ca increased from 0.08%±0.02% to 1.32%±1.1% (P<0.05), and Ac content increased from 0.23±0.14% to 0.79±0.17%. Bu content decreased over storage for both T1 and T2 from a level of 0.21±0.09% to 0.03±0.025 and 0.09±0.07, respectively.

The color of DGS changed from a golden yellow (0d) to a dark brown (113d) for T2. Little change was observed for T1. These data suggest that DGS can be successfully stored during the summer months with either salt or limestone, but salt was more effective.

**Key Words:** high moisture, distillers grains, storage

## Graduate Student Competitive Research Papers, Ph.D. Poster Division

**116 Determination of the contributions of cytochrome P450 2C (CYP2C) and 3A (CYP3A) to the hepatic catabolism of progesterone.** C. O. Lemley\* and M. E. Wilson, *West Virginia University, Morgantown.*

Several authors have observed a positive relationship between progesterone concentrations and conception rates. Peripheral concentrations of progesterone are affected by both production and catabolism. CYP2C and CYP3A enzymes play a pivotal role during the first step of steroid inactivation, which involves the addition of hydroxyl groups in various sites of the cyclopentanoperhydrophenanthrene nucleus. Our understanding of the contributions of hepatic catabolic enzymes to the total progesterone decay is limited. Our current objectives were to discern the proportional involvement of hepatic progesterone catabolic enzymes. Cells were dissociated from porcine livers using a non-perfusion technique. Confluent wells (n = 4/treatment) were preincubated with inhibitor and then challenged with 5 ng/ml progesterone for 30 min. Cell viability was unaffected by inhibitor (P > 0.10) and ranged from

77 to 81%. Control cells catabolized 55 ± 7% of the progesterone in 30 min. Cells exposed to ticlopidine, a CYP2C inhibitor, had a 48 ± 5% reduction (P < 0.01) in progesterone catabolism compared to the controls. Cells exposed to diltiazem, a CYP3A inhibitor, were not different from the controls (14 ± 4% inhibition; P > 0.10). A 31 ± 2% inhibition (P < 0.01) of progesterone catabolism was observed when cells were exposed to dicumarol, an inhibitor of glucuronosyltransferases. Curcumin, an inhibitor of CYP2C, CYP3A and glucuronosyltransferase, caused a 75 ± 4% reduction (P < 0.01) in progesterone catabolism. Cells exposed to naproxen, an aldo-keto reductase inhibitor, were not different from the controls (17 ± 5% inhibition; P > 0.10). Overall we inhibited 101 ± 9% of progesterone catabolism by inhibiting CYP2C, CYP3A, aldo-keto reductase and glucuronosyltransferase. The majority (61%) of the total progesterone catabolism in vitro can be accounted for by the CYP2C and CYP3A subfamilies. Future work focusing on decreasing these enzymes in vivo could lead to a reduction in progesterone catabolism during vital periods of gestation.

**Key Words:** cytochrome P450, progesterone, progesterone catabolism

## Growth, Development, Muscle Biology, and Meat Science

### 117 WITHDRAWN.

**118 Antioxidant capacity of calcium lactate on m-calpain activity in vitro.** Y. H. KIM\*, S. M. Lonergan, and E. Huff-Lonergan, *Iowa State University, Ames.*

Oxidation of postmortem muscle negatively affects proteolytic activity of calpains, and subsequently decreases tenderness of meat. Calcium lactate (CaLac) has free radical scavenging and antioxidant effects. Hence, it can be hypothesized that CaLac may both activate calpain and retard oxidative inhibition of calpain. The objective of this study was to determine the effects of CaLac on calpain activity under oxidizing conditions in vitro. Porcine skeletal muscle m-calpain (66 U/mg) was incubated with 40mM Tris-HCl, at 23°C for 5 min and 10 min with various combination of 100 µM H<sub>2</sub>O<sub>2</sub>, 5 mM CaCl<sub>2</sub>, and/or 5 mM CaLac generating 8 treatments; 1) control, 2) H<sub>2</sub>O<sub>2</sub>, 3) CaCl<sub>2</sub>, 4) CaLac, 5) H<sub>2</sub>O<sub>2</sub> + CaCl<sub>2</sub>, 6) H<sub>2</sub>O<sub>2</sub> + CaLac, 7) CaCl<sub>2</sub> + H<sub>2</sub>O<sub>2</sub>, and 8) CaLac + H<sub>2</sub>O<sub>2</sub>. The m-calpain activity was measured in a standard casein assay under both reducing and non-reducing conditions (with and without 0.2% MCE) in triplicate. In order to determine the effects of lactate concentration on calpain activity, m-calpain (66 U/mg) was incubated at the same conditions as above but with 50 µM H<sub>2</sub>O<sub>2</sub> and with 5 mM CaCl<sub>2</sub>, or CaLac (5, 10, 15, and 20 mM). Under both reducing and non-reducing conditions, CaLac activated m-calpain, similar to CaCl<sub>2</sub> ( $P > 0.05$ ). Pre-exposure of calpain with H<sub>2</sub>O<sub>2</sub> + CaLac treatment significantly lowered calpain activity compared to the H<sub>2</sub>O<sub>2</sub> + CaCl<sub>2</sub> under the reducing condition. These results suggest that CaLac may scavenge oxidants, which would allow more autolysis during pre-incubation, and consequently resulting in lower calpain activity ( $P < 0.05$ ). Increasing CaLac concentration decreased ( $P < 0.05$ ) the activity of m-calpain pre-incubated with H<sub>2</sub>O<sub>2</sub> under the reducing condition. Taken together these data suggest that the antioxidant capacity of CaLac may be concentration dependent, because the extent of m-calpain oxidation by H<sub>2</sub>O<sub>2</sub> was decreased with increasing lactate ion levels in aqueous solution. Thus, it can be concluded that CaLac is able to activate m-calpain, and may provide antioxidant capacity against m-calpain oxidation.

**Key Words:** calpain, calcium lactate, oxidation

**119 Influence of selection for reduced residual feed intake on pork quality.** R. M. Smith\*<sup>1</sup>, J. M. Young<sup>1</sup>, M. J. Anderson<sup>1</sup>, R. C. Johnson<sup>2</sup>, E. Huff-Lonergan<sup>1</sup>, J. Dekkers<sup>1</sup>, and S. M. Lonergan<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames*, <sup>2</sup>*Farmland Foods, Dennison, IA.*

Selection for improved growth efficiency has the potential to alter meat composition and fresh meat quality. The objective of this study was to determine the extent to which selection for reduced residual feed intake (RFI) affects pork composition and meat quality. The two lines evaluated in this study consisted of a line selected for reduced RFI over five generations (select) and a randomly selected control line (control). Selection for reduced RFI resulted in 0.052 kg lower RFI per day. Yorkshire gilts (select = 80, control = 89) were harvested and the boneless loins were collected at 24 hours postmortem. Back fat and loin eye depth were collected off the midline of the posterior part of the loin using the Fat-O-Meater. Quality attributes were measured at 2 and 3 days postmortem. Drip loss and water holding capacity were measured in duplicate. Hunter L, a, and b values were measured in triplicate on

two chops using a C10 illuminant, 10° observer, and 1.27cm aperture. Intramuscular lipid and moisture content were determined by AOAC guidelines. The model included the fixed effects of line, slaughter date, MC4R genotype, barn group, and line by slaughter date, and genotype by line interactions, off-test weight as a covariate, and sire, pen, and litter as random effects. There were no differences between lines for hot carcass weight, pH, drip loss, or Hunter L and a values. Compared to the control line, carcasses from the select line tended to have less ( $P=0.09$ ) backfat (15.2 ± 0.9 vs. 17.3 ± 0.7 mm), greater ( $P<0.05$ ) loin depth and greater ( $P<0.05$ ) calculated percentage of fat free lean (56.5% vs. 54.8%). Select line chops tended to have greater water holding capacity ( $P=0.07$ ). Loin chops from the select line had less ( $P<0.01$ ) intramuscular lipid content than control chops (1.14% vs. 1.67%). Select chops had a greater ( $P<0.01$ ) percentage of moisture than the control chops. Selection for reduced RFI has the potential to improve carcass composition with few detrimental effects on selected measures of meat quality.

**Key Words:** carcass composition, pork quality, residual feed intake

**120 Effects of different winter growing programs and subsequent finishing on gene expression in different adipose tissue depots in beef steers.** D. Stein\*<sup>1</sup>, A. Pillai<sup>1</sup>, U. DeSilva<sup>1</sup>, C. K. Krehbiel<sup>1</sup>, G. W. Horn<sup>1</sup>, M. McCurdy<sup>2</sup>, J. J. Wagner<sup>3</sup>, P. Ayoubi<sup>1</sup>, J. B. Morgan<sup>1</sup>, and R. D. Geisert<sup>4</sup>, <sup>1</sup>*Oklahoma State University, Stillwater*, <sup>2</sup>*Nutrition Service Associates, Kenmore, QLD, Australia*, <sup>3</sup>*Southeast Colorado Research Center, Colorado State University, Lamar, CO*, <sup>4</sup>*University of Missouri, Columbia.*

The objective was to determine gene expression profiles between SC and IM depots in beef steers from different winter growing programs. Steers of similar breed, type, and age were assigned to an initial harvest group or one of four treatment diets; steers placed in the feedlot after weaning and fed a high-concentrate diet (CF); steers grazed on wheat pasture (WP); steers fed a sorghum silage-based growing diet (SF); or steers program fed a high-concentrate diet (PF). SF and PF were fed to gain BW similar to WP. At the end of a 112 d growing phase (GP), 6 steers from WP, SF, and PF were harvested, with the remaining steers of WP, SF, and PF placed in the feedlot. At finish (FP), 6 steers from each diet were harvested at a common 12th-rib fat. SC and IM adipose tissue was collected from a 7.6 cm<sup>3</sup> section dissected from the LM at the 12th rib. Total RNA was extracted and cDNA microarray hybridizations performed. Preprocessing and normalization of data was accomplished utilizing the R-project statistical environment with the Bioconductor and LIMMA packages through GenePix AutoProcessor (GPAP 3.2). Ontology analysis of significantly differentially expressed genes was carried out using GFINDER. Ingenuity Pathways Analysis (IPA) was utilized to identify the most relevant biological mechanisms, pathways and functions of the annotated genes. Top functions of IPA network 1 for WP\_FP included cellular movement and cellular growth while top functions for IPA network 1 of both SF\_FP and PF\_FP included lipid metabolism and molecular transport. These findings provide insight into the regulation of adipogenesis in animals with different nutritional backgrounds.

**Key Words:** adipose tissue, bovine, gene expression

**121 Effects of DDGS on sow carcass fat quality.** A. N. Gipe\*, T. A. Houser, J. M. DeRouche, B. L. Goehring, S. L. Hillyard, A. W. Duttlinger, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelsen, *Kansas State University, Manhattan*.

An experiment was conducted to determine the effects of feeding non-pregnant sows a diet containing 50% dried distillers grains with solubles (DDGS) on carcass fat oxidation and composition. A total of 8 open sows were allotted to one of 2 diets by parity (average 2.3) and BW (initially 215 kg). One diet was a corn-soybean meal-based gestation diet, while the experimental diet was a corn-soybean meal-based diet that contained 50% DDGS. All sows were fed 2.27 kg of feed per day in a single feeding for 92-d. All sows were harvested on d 92 at the KSU Meat Laboratory, chilled for 48 h, fabricated into lean trimmings, ground, packaged in oxygen permeable overwrap and placed into simulated retail display. Overall (d 0 to 92), there were no differences ( $P > 0.64$ ) in BW (-1.5 vs 1.25 kg) or backfat (0.75 vs 0) change for sows fed either 0 or 50% DDGS. No differences ( $P > 0.23$ ) in lipid oxidation from lean trimmings as measured by 2-thiobarbituric acid reactive substances (TBARS) assay were reported either initially (0.128 vs 0.171 mg/kg) or after 5 d (0.249 vs 0.283 mg/kg) of retail display for sows fed either 0 or 50% DDGS. As expected, lipid oxidation increased ( $P < 0.003$ ) as measured by TBARS assay for both treatments from d 1 to 5. Jowl fatty acid analysis revealed an increase in linoleic acid ( $P < 0.01$ ; 12.66 vs 15.58%), total polyunsaturated fatty acids ( $P < 0.01$ ; 14.94 vs 18.12%), and ratio of polyunsaturated fatty acids to saturated fatty acids ( $P < 0.03$ ; 0.47 vs 0.58%) for sows fed 50% DDGS. Also, there was a trend for increased jowl iodine value ( $P < 0.08$ ; 69.33 vs 72.38) for sows fed 50% DDGS. In summary, feeding 50% DDGS to open sows for 92-d did not significantly affect BW, backfat, and lipid oxidation, but increased the concentration of linoleic acid and total polyunsaturated fatty acids and tended to increase jowl iodine value. However, the magnitude of unsaturation change to jowl fat for sows fed DDGS on a limit fed basis was not as great as previously observed in finishing pigs fed DDGS ad libitum.

**Key Words:** carcass fat quality, DDGS, sow

**122 Effects of distillers dried grains with solubles on carcass characteristics and meat quality traits.** J. L. Leupp\*, G. P. Lardy<sup>1</sup>, R. J. Maddock<sup>1</sup>, M. L. Bauer<sup>1</sup>, K. Karges<sup>2</sup>, M. L. Gibson<sup>2</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Dakota Gold Research Association, Sioux Falls, SD.

Seventy-two beef steers ( $296 \pm 9$  kg initial BW) were blocked by BW and used in a randomized complete block design with treatments arranged as a 2 x 2 factorial to determine effects of distillers dried grains with solubles (DDGS) on carcass characteristics, color, and sensory attributes. Main effects were feeding period (growing or finishing) and DDGS inclusion (0% or 30% DM basis replacing corn) resulting in 4 treatments: 0:0, 30:0, 0:30, and 30:30 (diet DDGS percentage fed during growing and finishing periods). Steers were fed individually a growing diet (65% concentrate) for 57 d then acclimated to and fed a finishing diet (90% concentrate) for 82 or 143 d. Diets were dry rolled corn, corn silage, grass hay, concentrated separator byproduct, and supplement. Diets included 27.5 mg/kg monensin and 11 mg/kg tylosin and were formulated to contain a minimum of 12.5% CP, 0.7% Ca, and 0.3% P. Longissimus muscle area ( $77.8 \pm 3.3$  cm<sup>2</sup>), 12th rib fat thickness ( $1.26 \pm 0.10$  cm), and KPH ( $2.48 \pm 0.16\%$ ) were not different ( $P \geq 0.16$ ). There were no differences ( $P \geq 0.21$ ) in yield grade ( $3.33 \pm 0.17$ ) or marbling ( $431 \pm 21$ ; Small<sup>0</sup> = 400). Results from a trained sensory panel (8-point hedonic scale) indicated no differences ( $P = 0.16$ ;  $6.03 \pm 0.16$ ) in tender-

ness; however, juiciness tended ( $P = 0.10$ ) to be greater in steaks from steers fed 30% compared with 0% DDGS during finishing ( $6.01$  vs.  $5.83 \pm 0.11$ ). A feeding period x DDGS interaction ( $P = 0.02$ ) occurred for flavor where 30:0 had the lowest value compared with other treatments. During the growing period, 30% DDGS inclusion tended to lower L\* ( $P = 0.08$ ;  $48.6$  vs.  $48.9 \pm 0.2$ ) and lowered b\* ( $P = 0.01$ ;  $8.24$  vs.  $8.65 \pm 0.18$ ) of steaks. A feeding period x DDGS interaction occurred ( $P = 0.02$ ) for a\* where feeding DDGS continuously had the lowest a\* and feeding DDGS during growing phase had the greatest a\*. Feeding 30% DDGS did not impact any carcass characteristics, but did influence steak sensory attributes and color.

**Key Words:** carcass characteristics, distillers dried grains with solubles, meat quality

**123 Mineral Content of m. Teres major and m. Infraspinatus from Steers Fed Wet Distillers Grains plus Solubles and Vitamin E.** A. S. de Mellor Jr.\*, L. S. Senaratne, K. Watanabe, J. A. Driskell, M. I. Schnepf, F. L. Hamouz, and C. R. Calkins, *University of Nebraska, Lincoln*.

The aim of this work was to investigate the mineral content of m. *Teres major* (TER) and m. *Infraspinatus* (INF) muscles from steers fed 0 or 40% WDGS (DM basis) with or without 500 I.U. of vitamin E/head/d for 100 d. Steers (n = 32) were allocated to 4 treatments: 0% WDGS, 0% WDGS vit. E, 40% WDGS, or 40% WDGS vit. E. After 7 d of aging, TER and INF muscles were excised from shoulder clods (IMPS # 114) and analyzed for percentage Ca, P, K, Mg, S, and Na, and ppm of Zn, Fe, Mn, and Cu. The TER muscles were analyzed raw and pan fried whereas INF muscles were analyzed raw, pan fried and grilled. Muscles were cooked to 70°C. For raw TER, higher values ( $P \leq 0.05$ ) of P were observed in samples from animals fed 40% vit. E (0.22) when compared to 0% (0.20). Also, higher P ( $P \leq 0.05$ ) was identified in pan fried TER samples from 0% vit. E (0.26) when compared to 0% (0.24). Values of K of raw TER were higher in samples from treatment 40% vit. E (0.34) than 0% vit. E (0.32). Higher Fe ( $P \leq 0.05$ ) was observed in pan fried TER samples from animals fed 0% vit. E (28.33) when compared to 0% (24.28) whereas higher S ( $P \leq 0.05$ ) was identified in 40% vit. E (0.27) when compared to 0% vit. E (0.22). No significant differences were observed in Na values among raw or pan fried TER. For INF, raw samples from 40% vit. E (0.19) had higher P ( $P \leq 0.05$ ) than samples from 0% vit. E (0.17). Values of Fe were higher ( $P \leq 0.05$ ) in grilled samples of INF from steers fed 0% vit. E (41.00) than from 40% vit. E (33.88). Iron was also higher ( $P \leq 0.05$ ) in 40% vit. E pan fried INF samples (40.50) than 0% vit. E samples (32.83). Raw INF samples from 40% vit. E (0.21) had higher S ( $P \leq 0.05$ ) than 0% vit. E (0.16). Sodium values were higher ( $P \leq 0.05$ ) in raw INF samples from 40% vit. E (0.076) than 0% vit. E (0.066). Although differences were observed among treatments, no pattern was identified regarding the effect of WDGS or vit. E supplementation on mineral content of beef.

**Key Words:** beef, minerals, distillers grain

**124 Effect of birth weight on growth performance, tissue accretion, and carcass composition of barrows to 145 kg body weight.** B. A. Peterson\*, M. Ellis<sup>1</sup>, G. Hollis<sup>1</sup>, J. Killefer<sup>1</sup>, F. K. McKeith<sup>1</sup>, C. M. Peterson<sup>1</sup>, C. L. Puls<sup>1</sup>, N. Williams<sup>2</sup>, and B. F. Wolter<sup>3</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>PIC USA, Hendersonville, TN, <sup>3</sup>The Maschhoffs, Carlyle, IL.

The effects of birth weight on growth performance, tissue accretion, and carcass composition were evaluated using 72 crossbred barrows reared

from birth to 145 kg BW. The study was conducted as a RCBD with 1 treatment (birth weight classification) and 3 levels: Heavy (average of 2.3 kg; range of 2.0 – 2.6 kg); Medium (average of 1.6 kg; range of 1.3 – 1.9 kg); Light (average of 0.90 kg; range of 0.6 – 1.2 kg). The 3 birth weight classifications were selected from within the same birth litter. There were 24 replicates blocked by weaning day; during the first 3 weeks post-weaning (acclimation period) pigs were housed in pens of 6 and, subsequently, in individual pens for the duration of the growth study. Pigs were weighed at birth, weaning, and every two weeks thereafter until 145 kg BW; all feed additions and feed left in the feeder at the time of pig weighing were recorded. At 145 kg BW, pigs were harvested using standard procedures. Standard carcass measurements were taken ~24 h post-mortem. The right side of each carcass was separated into skin, bone, and soft tissue; each tissue was weighed, and the soft tissue was ground. Proximate analysis was conducted on ground tissue to determine carcass fat-free lean. Light birth weight pigs had lower ( $P < 0.05$ ) average daily gain from birth to 145 kg BW; gain:feed ratio was numerically lower ( $P = 0.21$ ) for the light pigs, however, average daily feed intake was not different ( $P > 0.05$ ) between birth weights. Light birth weight pigs had numerically lower carcass fat-free lean percentage and fat-free lean accretion rate; however, these differences were not statistically different ( $P > 0.05$ ). The results of this study indicate that light birth weight pigs grow slower to harvest weight, however, medium and heavy birth weight pigs have similar growth performance.

**Key Words:** birth weight, pigs, growth

**125 Effects of birth weight and weaning weight on pig growth performance, tissue accretion, carcass characteristics, and meat quality.** B. A. Peterson<sup>\*1</sup>, M. Ellis<sup>1</sup>, G. Hollis<sup>1</sup>, J. Killefer<sup>1</sup>, F. K. McKeith<sup>1</sup>, C. M. Peterson<sup>1</sup>, C. L. Puls<sup>1</sup>, N. Williams<sup>2</sup>, and B. F. Wolter<sup>3</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>PIC USA, Hendersonville, TN, <sup>3</sup>The Maschhoffs, Carlyle, IL.

The effects of birth weight and weaning weight on growth performance, tissue accretion, carcass characteristics, and pork quality were evaluated using 96 crossbred gilts reared from weaning ( $21 \pm 1$  d;  $7.14 \pm 0.38$  kg BW) to 125 kg BW. A RCBD was used with a  $2 \times 2$  factorial arrangement of the following treatments: 1) Birth weight [Heavy ( $1.75 \pm 0.23$  kg BW) and Light ( $1.30 \pm 0.24$  kg BW)] and 2) Weaning weight (Heavy and Light). Heavy and Light birth weight pigs were selected from within the same birth litter. Differences in weaning weight were achieved by rearing pigs in litters of either 6 (Heavy) or 12 (Light) during lactation. There were 8 replicates blocked by weaning day and pigs were housed in groups of 3 pigs/pen. Pigs were weighed at birth, weaning, and every two weeks thereafter until an average pen weight of 125 kg, and all feed additions and feed left in the feeder at the time of pig weighing were recorded. Beginning at ~30 kg BW, backfat depth and longissimus muscle area were measured using ultrasound and fat-free lean was estimated based on published prediction equations. At 125 kg BW, pigs were harvested using standard procedures. Standard carcass measurements were taken ~24 h after harvest. Light birth weight pigs had lower ( $P < 0.05$ ) daily gain and tended ( $P = 0.06$ ) to have lower gain:feed, however, daily feed intake did not differ between birth weights. Fat-free lean growth rate and carcass lean percentage were lower for light birth weight pigs, but there was no effect of birth weight on pork quality measures. Weaning weight had no effect on overall growth performance or carcass and meat quality characteristics. This study suggests that birth weight influences live weight and tissue growth to harvest weight, but that manipulating piglet growth rate in lactation to increase or decrease weaning weight has no effect on subsequent growth performance.

**Key Words:** birth weight, weaning weight, pigs

**126 Effects of maternal nutritional plane and selenium supply on carcass composition of offspring.** E. Harris<sup>\*</sup>, J. Galbreath, J. Caton, P. Berg, E. Berg, K. Vonnahme, D. Redmer, L. Reynolds, and K. Carlin, North Dakota State University, Fargo.

The objective was to determine impacts of maternal nutritional plane, high Se, or a combination on carcass composition of offspring at harvest. Pregnant rambouillet ewe lambs ( $n=82$ ) were allotted randomly to 1 of 6 treatments in a  $3 \times 2$  factorial design that included plane of nutrition (60% [RES], 100% [CON], and 140% [HIGH]) and dietary levels of Se (adequate Se [ASe;  $9.5 \mu\text{g/kg BW}$ ] vs. high Se [HSe;  $81.8 \mu\text{g/kg BW}$ ] from enriched yeast). Treatments were initiated at breeding for Se and d 50 of gestation for nutrition. Pelleted diets were fed once daily (36.5% beet pulp, 22.3% alfalfa meal, 16.2% corn, 18% soybean hulls, and 7.0% soybean meal; 14.4% CP, 2.63 Mcal ME/kg; DM basis). Immediately after parturition, all lambs were removed from dams, fed commercial colostrum, and were conventionally raised to approximately 60 kg. After harvest, hot carcass weight and USDA yield grade were determined. Lamb tissues were dissected into lean, bone, and three fat depots that consisted of subcutaneous fat (SUB), perirenal fat (INT), and intermuscular fat (SEAM) from left lamb sides split along backbone. Data was analyzed using ANOVA with fetal number included in the model if significant ( $P < 0.05$ ). Maternal treatments did not affect ( $P > 0.05$ ) whole carcass weights ( $24.67 \text{ kg} \pm 3.2$ ) or USDA Yield Grade ( $3.3 \pm 1.3$ ). INT was greater ( $P = 0.007$ ) in lambs from HSe ( $515.1 \text{ g} \pm 44.6$ ) than ASe ( $379.7 \text{ g} \pm 55.5$ ). Treatments did not differ ( $P > 0.05$ ) for lean ( $4559.9 \text{ g} \pm 657.2$ ), bone ( $2503.8 \text{ g} \pm 274.3$ ), SUB ( $2615.9 \text{ g} \pm 743.5$ ), or SEAM ( $1527.1 \text{ g} \pm 425.7$ ). Maternal nutrition of ewe lambs did not affect carcass composition of offspring.

**Key Words:** maternal nutrition, composition, selenium

**127 Obesity alters proteoglycan mRNA abundance in the subcutaneous fat depot of the Ossabaw Miniature swine.** A. Adedokun<sup>\*1</sup>, O. Adeola<sup>1</sup>, M. Sturek<sup>2</sup>, and K. Ajuwon<sup>1</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Indiana University-Purdue University, Indianapolis.

Increasing efficiency of lean growth in swine requires increased repartitioning of nutrients towards lean muscle accretion and reduction in the amount that is channeled towards adipose tissue formation. Although substantial progress has been made in reducing backfat thickness through generations of rigorous genetic selection, there is increasing evidence that commercial swine have not attained their genetic potential for lean growth. More rapid progress in reducing backfat thickness will require discovery of novel gene networks that regulate adipocyte differentiation and lipid accretion. Therefore, we have examined the effect of obesity on the expression of two proteoglycans, biglycan and decorin, in the adipose tissue of Ossabaw miniature pigs fed either a control (low fat) or a high fat diet. Using RT-PCR, we established that feeding high fat diet results in obesity and is associated with a significant reduction (approx 70%) in the mRNA abundance of biglycan and decorin in the subcutaneous depot of obese vs. lean pigs ( $P < 0.050$ ). Determining the role of biglycan and decorin in adipose tissue development in swine could lead to new strategies for lowering backfat thickness and enhancing efficiency of lean growth.

**Key Words:** swine, adipocyte, proteoglycans

**128 Flavor of beef value cuts from cattle fed wet distillers grains plus solubles and vitamin E.** K. Watanabe\*, M. I. Schnepf, A. S. de Mello Jr., J. A. Driskell, and C. R. Calkins, *University of Nebraska, Lincoln*.

Feeding wet distillers grains plus solubles (WDGS) increases polyunsaturated fatty acid content in beef which accelerates oxidation and causes changes in color stability and flavor during retail display. This study was conducted to determine the effects of feeding WDGS and vitamin E on flavor of beef value cuts. Yearling, crossbreed steers were randomized in four groups and fed with four different finishing diets (0% or 40% WDGS - DM basis - with or without vitamin E). After grading, knuckles and shoulder clods were removed from 29 USDA Choice beef carcasses (n=6 to 8 per treatment), vacuum-packaged and aged for 7 days. The m. *teres major* (TER) and m. *infraspinatus* (INF) were removed and stored at -80°C. Trained sensory panelists (n=9) evaluated tenderness, juiciness, intensity of off-flavor and types of off-flavor on broiled TER, broiled INF and grilled INF. The presence of WDGS in the diet improved tenderness ratings in broiled TER (P = 0.02) and grilled INF (P = 0.12). Neither juiciness nor off-flavor intensity were affected by feeding WDGS or vitamin E. The most common off-flavor note was livery (detected by 20 to 30% of the panelists in most cases), although the incidence was not treatment dependant (P = 0.30 to 0.76 among treatments). Numerically, the lowest incidences of livery off-flavors for grilled INF and broiled INF were found in cattle fed vitamin E in the absence of WDGS. The TER from cattle fed WDGS more frequently had (P = 0.07) oxidized flavors than TER from cattle not fed WDGS, but the overall incidence was low (2 - 5%). Bloody flavor notes were detected about twice as often (P = 0.06) in broiled INF from cattle not fed WDGS than those fed WDGS (12 - 15% versus 6 - 7%, respectively). These data suggest that feeding 40% WDGS tends to improve tenderness and has minimal effects on the development of off flavors when steaks are not subjected to retail display.

**Key Words:** distillers grains, vitamin E, flavor

**129 Protein nitrosylation in postmortem beef longissimus dorsi and psoas major muscles.** W. Zhang\*, S. M. Lonergan, and E. Huff-Lonergan, *Iowa State University, Ames*.

This study was designed to determine protein nitrosylation in postmortem beef longissimus dorsi and psoas major muscles. The hypothesis was that muscle fiber type may be related to the extent of protein nitrosylation. Nitric oxide is a free radical that can be produced in many tissues. Nitric oxide synthase catalyzes the production of nitric oxide in skeletal muscle. Nitric oxide can induce protein nitrosylation to regulate protein functions including cysteine enzyme activity. The distribution of nitric oxide synthase is muscle fiber type dependent. Muscles with higher percentage of type II fibers have greater amounts of nitric oxide synthase. Longissimus dorsi has a higher percentage of type II fibers and a lower percentage of type I fibers than the psoas major. Thus, these two beef muscles may be different in the extent of protein nitrosylation. In this study, we compared the levels of protein nitrosylation between postmortem beef muscles with different muscle fiber composition (longissimus dorsi and psoas major). Beef muscles from four market weight steers were aged in vacuum package for 1 day postmortem at 4 °C before nitrosylation analysis (S-Nitrosylated Protein Detection Assay Kit-Cayman Chemical Company, Ann Arbor, MI). This assay is a method to detect S-nitrosylated proteins. In all samples, several protein bands were detected as being nitrosylated. A significant difference was found in protein nitrosylation between the two muscles. At day 1 of postmortem storage, the longissimus dorsi showed higher

intensity of protein nitrosylation than the psoas major (P<0.01). No significant differences of protein nitrosylation were found among the four animals in either muscle (P>0.05). In conclusion, protein nitrosylation can be detected in postmortem beef muscles during aging. Muscle fiber composition could influence the extent of protein nitrosylation between muscles. The extent of nitrosylation should be considered as an undefined source of variation in fresh meat quality.

**Key Words:** nitrosylation, longissimus dorsi, psoas major

**130 Microbial translocation and tenderness of needle-free and needle injection enhancement of beef strip loins.** A. N. Sutterfield<sup>1</sup>, B. A. Crow<sup>1</sup>, M. E. Dikeman\*<sup>1</sup>, R. K. Phebus<sup>1</sup>, J. A. Grobbel<sup>2</sup>, and L. C. Hollis<sup>1</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*Michigan State University, East Lansing*.

The objective was to determine the effects of needle-free injection (NF) and traditional needle injection (N) on microbial translocation of generic E. coli in beef strip loins. Longissimus muscles (LM) (n=5) from USDA Select carcasses were used in preliminary research to determine the optimal pressure (psi) for NF injections. Seven psi treatments were administered with sterile colored saline solution: 90, 55, 50, 45, 30, 25 or 20 psi, with 25 psi selected as optimum. An additional 15 strip loins were halved and surfaces inoculated with generic E. coli at a level of 10<sup>6</sup> CFU/cm<sup>2</sup> (3 replications of 5 strip loins). Matching halves were allocated to NF or N injection with a phosphate and salt solution. Immediately after injection, 2 cores, 23 cm<sup>2</sup> in area, were taken aseptically from each half. Using sterile technique, a 2-mm thick cross-sectional slice was removed from the external, inoculated surface of the core. The 2 cores from each half were sliced into cross-sectional slices at depths of 1, 3, and 5 cm. The 2 core samples for each depth were combined in stomacher bags with 99 ml peptone water and stomached; serial dilutions were then plated. Slice shear force measurements were obtained from a 1-cm thick slice from the lateral end of the steak parallel to muscle fibers and shearing them perpendicular to muscle fibers. Samples taken from the surface of N injected muscles had lower (P < 0.05) microbial counts than NF-injected muscles (2.79 versus 3.23 log CFU/g, respectively). Also, the 3- and 5-cm depth samples from N injection had the least (P < 0.05) microbial contamination (1.69 and 2.12 log CFU/g, respectively). Traditional N injection resulted in approximately 0.5 log CFU/g less microbial contamination at all depths. Both treatments resulted in acceptable tenderness; however, NF injection improved (P < 0.05) tenderness over N injection. The N injection posed fewer microbial risks but higher shear force compared with NF injection.

**Key Words:** beef, injection enhancement, microbial translocation

**131 Restaurant patrons' perceptions of North Dakota and guaranteed tender labeling relative to price paid and palatability.** A. N. Lepper\*, R. J. Maddock, and E. P. Berg, *North Dakota State University, Fargo*.

The objective of the study was to determine if restaurant consumers are willing to pay a premium for North Dakota raised, known tender steaks and, if so, their perception of tenderness, juiciness and flavor. Three restaurants in Fargo, North Dakota were selected based on menu ribeye price and willingness to collaborate. Restaurants were classified into one of three categories: high steak cost (≥ \$25.00); medium (\$15.00 to \$24.00); and low (≤ \$15.00). The "North Dakota Tendercut" ribeye steak was offered as an evening feature at each restaurant on Thursday, Friday, and Saturday nights on three non-consecutive weeks. The price of the North Dakota Tendercut ribeye was 10, 20, or 30% higher than

the restaurant's menu ribeye. After patrons consumed their meal, they were asked to fill out a survey consisting of eight questions regarding their eating experience. The second question of the survey asked the consumers to rank the following factors in order from 1 to 7 based on their purchasing decision: price, featured beef item, North Dakota product, classified as tender, waitress/waiter recommendation, suggested by a friend, and other. Across all restaurants 116 ribeye steaks were sold. Survey results found that consumer purchasing decisions were affected, in order by: North Dakota product (30%), staff recommended (25%), tender (16%), featured item (15%), friend (7%), price (4%), and other (4%). Consumers were asked to rank tenderness, juiciness, and flavor on a scale from 1 to 9 with 9 being the highest value for each category. Consumers rated steaks higher in tenderness ( $P = 0.05$ ) as purchase price increased. Furthermore, there was a tendency to rate steaks higher in juiciness ( $P = 0.09$ ) and flavor ( $P = 0.08$ ) respectively as purchase price increased.

**Key Words:** steak, consumer, tenderness

**132 Optimizing beef cuts: Comparison of sensorial attributes and objective tenderness of m. *Obliquus abdominis* and m. *Splenius*.** C. R. Calkins, A. S. de Mello Jr.\*, and L. S. Senaratne, *University of Nebraska, Lincoln*.

Flank steak (m. *Obliquus abdominis*) is a popular beef cut. The m. *Splenius* is from the chuck and has physical characteristics similar to flank steak. The objectives of this study were to compare sensorial attributes and shear force values between m. *Splenius* and flank steaks. The m. *Splenius* were excised from 15 steers and 15 heifers selected according to three weight ranges (340 - 362, 363 - 385, and 386 - 408 kg; 5 heifers and 5 steers per range). Flank steaks ( $n = 30$ ) were obtained directly from a commercial manufacturer. Steaks were thawed 24 hr at 3°C, dry ( $n = 10$  each) or moist ( $n = 10$  each) heat cooked to 70°C, and evaluated for Warner-Bratzler shear force. Steaks were divided in 4 regions from cranial to caudal to analyze differences in shear force within muscle. For sensorial attributes, steaks ( $n = 10$  each) were dry heat cooked and sliced thin (6 mm). A consumer taste panel (about 24 panelists per session) evaluated tenderness, flavor and overall desirability on 8-point hedonic scales where the higher number is more desirable. The m. *Splenius* from heavy weight steers were significantly heavier than all other sex and weight categories (1.20 versus 0.73 kg for heavy steers versus all other categories, respectively.) No differences in shear force (kg) were observed among regions within a steak for flank steaks and m. *Splenius*, regardless of cooking method ( $P \geq 0.40$ ). Neither were there differences in shear force when comparing muscles for dry or moist heat cookery (shear force = 6.05 and 5.92 kg for dry heat cookery and 4.73 and 4.36 kg for moist heat cookery for m. *Splenius* and flank, respectively.) No differences existed for sensorial traits among muscles (tenderness = 4.84 and 4.59; flavor = 5.13 and 5.07; overall desirability = 4.95 and 4.86 for m. *Splenius* and flank, respectively). Therefore, the m. *Splenius* is similar to flank steak in tenderness, sensorial attributes, and value.

**Key Words:** beef, flank steak, splenius

**133 Internal color and tenderness of the infraspinatus are affected by cooking method and degree of doneness.** M. D. Wharton\*, J. K. Apple, J. W. S. Yancey, J. T. Sawyer, and M. S. Lee, *University of Arkansas Division of Agriculture, Fayetteville*.

The infraspinatus (IF) from USDA Select clods was used to test the effects of cookery method and internal endpoint temperature on Warner-Bratzler shear force (WBSF) and cooked beef color. Steaks ( $n$

= 360) from IF aged 0, 7, 14, 21, 28, and 35 d at 2°C were cut, labeled, vacuum-packaged, and frozen at -30°C for approximately 60 d before being cooked to 3 different endpoint temperatures (65.5, 71.1, or 76.6°C) using: 1) an air-impingement oven (IMP); 2) a clam-shell griddle (PANI); 3) forced-air convection oven (BLOD); 4) counter-top, electric griddles (GRID); or 5) gas-fired, open-hearth chargrill (CHAR). All steaks were cooled 1 h before being sliced perpendicular to the cut surface, and instrumental color was measured immediately after cutting. Then, six 1.27-cm-diameter cores were removed parallel with the muscle fiber orientation and sheared once through the center with a WBSF device attached to an Instron Universal testing machine. Steaks cooked in the BLOD to 76.6°C had the longest ( $P < 0.05$ ), and steaks cooked on the PANI to 65.5°C had the shortest, cooking times (endpoint temperature  $\times$  cooking method,  $P < 0.01$ ). Moreover, cooking losses were greatest ( $P < 0.05$ ) in steaks cooked to 76.6°C and least ( $P < 0.05$ ) in steaks cooked to 65.5°C, whereas steaks cooked on CHAR and PANI had the highest ( $P < 0.05$ ) and lowest ( $P < 0.05$ ) cooking losses, respectively. Steaks cooked to 65.5° and 76.6°C had the lowest ( $P < 0.05$ ) and greatest ( $P < 0.05$ ) WBSF values, respectively, and steaks cooked in the PANI and BLOD had the lowest ( $P < 0.05$ ) and greatest ( $P < 0.05$ ) WBSF values, respectively. Interestingly, steaks cooked to 65.5°C in the PANI had the reddest ( $P < 0.05$ ) internal cooked color, but steaks cooked to 76.6°C in the PANI had the least ( $P < 0.05$ ) red internal color (endpoint temperature  $\times$  cooking method,  $P < 0.01$ ). Although cooking in the PANI resulted in the lowest cooking losses and WBSF values, results from this study indicate that endpoint temperature has a greater effect on tenderness and cooked beef color of the IF than cookery method.

**Key Words:** beef, infraspinatus, cookery method

**134 Internal color and tenderness of the semimembranosus are affected by cooking method and degree of doneness.** M. D. Wharton\*, J. K. Apple, J. W. S. Yancey, J. T. Sawyer, and M. S. Lee, *University of Arkansas Division of Agriculture, Fayetteville*.

The semimembranosus (SM) from USDA Select top rounds was used to test the effects of cookery method and internal endpoint temperature on shear force (WBSF) and cooked beef color. Semimembranosus steaks ( $n = 360$ ) from top rounds aged 0, 7, 14, 21, 28, and 35 d at 2°C were cut, labeled, vacuum-packaged, and frozen at -30°C for approximately 60 d before being cooked to 3 different endpoint temperatures (65.5, 71.1, or 76.6°C) using: 1) an air-impingement oven (IMP); 2) a clam-shell griddle (PANI); 3) forced-air convection oven (BLOD); 4) counter-top, electric griddles (GRID); or 5) gas-fired, open-hearth chargrill (CHAR). Steaks were cooled 1 h before being sliced perpendicular to the cut surface, and instrumental color was measured immediately after cutting. Then, six 1.27-cm-diameter cores were removed parallel with the muscle fiber orientation to measure WBSF. Steaks cooked to 76.6 and 65.5°C had the greatest ( $P < 0.05$ ) and lowest ( $P < 0.05$ ) cooking loss percentages, respectively, whereas steaks cooked in the PANI had the lowest ( $P < 0.05$ ) cooking losses and GRID-cooked steaks had lower ( $P < 0.05$ ) cooking loss percentages than those cooked in the BLOD, CHAR or IMP. Shear force values increased ( $P < 0.05$ ) with each increase in endpoint temperature, and steaks cooked on the CHAR had greater ( $P < 0.05$ ) WBSF values than steaks cooked in the BLOD, IMP, PANI, and on the GRID when cooked to either 65.5 or 76.6°C (endpoint temperature  $\times$  cooking method,  $P < 0.01$ ). Furthermore, internal color of SM steaks cooked in the BLOD was lighter (greater L\* values;  $P < 0.05$ ) and less ( $P < 0.05$ ) yellow (lower b\* values) than steaks cooked on the CHAR, GRID or PANI, whereas internal color of steaks cooked to 65.5°C was redder (greater a\* values;  $P < 0.05$ ) and more yellow ( $P < 0.05$ ) than steaks cooked to 76.6°C. Cooking SM steaks to 76.6°C resulted in the

greatest cooking losses and WBSF values, especially when cooked upon the CHAR, and, although cooking steaks in the PANI reduced cooking

times, broiling SM steaks on inexpensive GRID produced the lowest WBSF values, regardless of endpoint temperature.

**Key Words:** beef, semimembranosus, cookery method

## Nonruminant Nutrition

**135 Effect of DDGS source on growth performance and carcass characteristics of growing-finishing pigs.** A. J. Drescher\*<sup>1</sup>, S. K. Baidoo<sup>2</sup>, L. J. Johnston<sup>3</sup>, and G. C. Shurson<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Southern Research and Outreach Center, Waseca, MN, <sup>3</sup>West Central Research and Outreach Center, Morris, MN.

The objective of this study was to evaluate the effects of DDGS sources differing in quality on the growth performance and carcass characteristics of growing-finishing pigs. Pigs ( $n = 448$ ;  $BW = 62.7 \pm 0.11$  kg) were fed one of 4 experimental diets (14 pens/treatment; 8 pigs/pen) in a 2-phase feeding program to a final BW of  $115.8 \pm 0.23$  kg. Diets consisted of a corn-soybean meal diet (CON), and diets containing 20% DDGS from a source with high CP and digestible Lys (DLys) content (29.5 and 0.68%, respectively; HDDGS), 20% DDGS from a mid range CP and DLys source (28.6 and 0.60%, respectively; MDDGS), and 20% DDGS from a source with low CP and DLys (27.6 and 0.52 %, respectively; LDDGS). Diets were formulated on a digestible AA basis containing equal levels of DLys achieved by adjusting soybean meal inclusion. All diets contained 0.15% L-lys HCl. Diets were formulated with NRC (1998) AA digestibility values for corn and soybean meal, and source specific DDGS AA digestibility values obtained in a previous study. Overall ADG was decreased for pigs fed LDDGS (0.96 kg/d;  $P < 0.05$ ) compared to those fed CON (1.00 kg/d). However, ADG of HDDGS and MDDGS-fed pigs (both 0.98 kg/d,  $P > 0.34$ ) were not different from CON. Pigs fed CON (2.98 kg/d) had greater ADFI than HDDGS and LDDGS (2.83 and 2.84 kg/d, respectively,  $P < 0.05$ ), but not MDDGS (2.90 kg/d). Overall G:F was higher for HDDGS compared to CON ( $P < 0.04$ ), but not different among other treatments ( $P > 0.13$ ). There were no differences in final BW among dietary treatments ( $P > 0.11$ ). Dressing % for CON (75.5%) was greater than HDDGS and MDDGS (74.9 and 74.8%, respectively,  $P < 0.05$ ), but not greater than LDDGS (75.4%,  $P > 0.97$ ). Last rib backfat depth was reduced ( $P < 0.05$ ) for pigs fed HDDGS compared to CON. There were no differences in % carcass lean ( $P > 0.75$ ) among dietary treatments. These results suggest that DDGS sources of lower CP and DLys may reduce pig performance, while higher quality DDGS sources can support performance similar to a corn-soybean meal diet. Feeding diets containing 20% DDGS from some sources may also reduce carcass dressing percentage but has no effect on % carcass lean.

**Key Words:** pigs, DDGS, growth

**136 Effects of distillers dried grains with solubles and high-protein distillers dried grains on growth performance and organ weights of growing and finishing pigs.** N. A. Gutierrez\*, D. Y. Kil, B. G. Kim, and H. H. Stein, University of Illinois, Urbana.

Two experiments were conducted to evaluate the effects of feeding distillers dried grains with solubles (DDGS) and high protein distillers dried grains (HP-DDG) on growth performance and organ weights. Two sources of DDGS, DDGS<sub>Poet</sub> and DDGS<sub>Palestine</sub>, and 1 source of HP-DDG were used. In Exp. 1, a total of 36 growing pigs ( $20.8 \pm 2.06$  kg BW) were randomly allotted to 4 dietary treatments with 9 replicate pigs per treatment. Pigs were housed individually in  $0.9 \times 1.8$  m pens

and they had free access to feed and water throughout the experiment. Treatments included a basal diet based on corn and soybean meal, and 3 diets that were formulated by mixing 70% of the basal diet and 30% of each source of DDGS or HP-DDG. At the end of the 28-d feeding trial, all pigs were killed, digesta were removed from the intestinal tract, and carcass, blood, intestines, and non-intestine organs were weighed. Growth performance was not affected by dietary treatments. Pigs fed the diet containing DDGS<sub>Poet</sub> had a lower digesta-free BW, measured as a sum of blood, cold carcass, empty intestines, and other organs, than those fed the basal diet (38.5 vs. 42.5 kg;  $P \leq 0.05$ ). The ratio of total non-intestine organ weight (liver, heart, kidney, lungs, and spleen) to the digesta-free BW was greater ( $P \leq 0.05$ ) for pigs fed the diet containing HP-DDG than for pigs fed the basal diet (0.057 vs. 0.052). In Exp. 2, a total of 36 finishing pigs ( $87.2 \pm 9.77$  kg BW) were used in a 35-d feeding trial with the same treatments and experimental procedures as in Exp. 1. Pig growth performance was not influenced by dietary treatments. Pigs fed the diet containing HP-DDG had a greater total non-intestine organ weight than those fed the diet containing DDGS<sub>Palestine</sub> (4.78 vs. 4.31 kg;  $P \leq 0.05$ ), but all other organ weights were not influenced by dietary treatments. In conclusion, performance of growing and finishing pigs was not influenced by the inclusion of 30% DDGS or HP DDG in the diet, but carcass and organ weights may be affected by the use of DDGS or HP DDG.

**Key Words:** distillers dried grains with solubles, high-protein distillers dried grains, pigs

**137 Effects of low-solubles distiller's dried grains (LS-DDG) in diets for growing-finishing pigs: Energy content and pig growth performance.** R. B. Amaral\*<sup>1</sup>, L. J. Johnston<sup>2</sup>, J. E. Anderson<sup>3</sup>, S. K. Baidoo<sup>4</sup>, and G. C. Shurson<sup>1</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>West Central Research and Outreach Center, Morris, <sup>3</sup>University of Minnesota, Morris, <sup>4</sup>Southern Research and Outreach Center, Waseca.

Two experiments were conducted to assess the energy content of LS-DDG and its effects on growth performance when fed to growing-finishing pigs. In Exp. 1, barrows ( $n = 48$ ;  $51.9 \pm 2.05$  kg of BW) were assigned randomly to one of six dietary treatments in a metabolism study. The basal diet (B) was formulated on a total amino acid basis following NRC (1998) nutrient requirements for pigs gaining 350 g/d of lean tissue. The LS-DDG or distiller's dried grains with solubles (DDGS) were combined with basal diet to yield five additional diets: L30, L40, and L50 (30, 40, and 50% LS-DDG, respectively), and D30 and D40 (30 and 40% DDGS, respectively). Crude fat content of LS-DDG (7.95%) was lower than DDGS (8.87%). Increased dietary LS-DDG level decreased DE content (DM basis) of diets (B = 3,753 kcal/kg; L30 = 3,595 kcal/kg; L40 = 3,525 kcal/kg; L50 = 3,537 kcal/kg; PSE = 27.9). The DE content of LS-DDG and DDGS used in this experiment were  $3,231 \pm 77$  and  $3,351 \pm 76$  kcal/kg DM, respectively. In Exp. 2, pigs ( $n = 216$ ;  $18.8 \pm 0.76$  kg initial BW) were blocked by weight and pens were assigned randomly to one of three dietary treatments in a 4-phase feeding program (24 pens, 9 pigs/pen). Diets were formulated on a SID amino acid basis following NRC (1998) nutrient requirements

for pigs gaining 350 g/d of lean tissue. Diets included a corn-soybean meal control (C); C containing 20% LS-DDG (L); and C containing 20% DDGS (D). Overall final BW (C = 113.8 kg; L = 112.1 kg; D = 114.0 kg; PSE = 0.90), ADG (C = 0.88 kg; L = 0.86 kg; D = 0.88 kg; PSE = 0.01), and ADFI (C = 2.32 kg; L = 2.35 kg; D = 2.39 kg; PSE = 0.04) were similar ( $P > 0.27$ ) among treatments. Pigs fed L exhibited similar ( $P = 0.90$ ) G:F compared to pigs fed D, but tended ( $P = 0.09$ ) to have lower G:F compared to pigs fed C (C = 0.380; L = 0.367; D = 0.370; PSE = 0.004). Inclusion of 20% LS-DDG in diets for growing-finishing pigs supports ADG and ADFI similar to that of diets containing 20% DDGS. However, gain efficiency of pigs fed 20% LS-DDG may decline slightly compared to pigs fed corn-soybean meal diets.

**Key Words:** energy, growth, low-solubles distiller's dried grains

**138 Corn distillers dried grains with solubles (DDGS) in diets for growing-finishing pigs – a cooperative study.** G. L. Cromwell\*, M. J. Azain, O. Adeola, S. D. Carter, T. D. Crenshaw, S. W. Kim, D. C. Mahan, P. S. Miller, and M. C. Shannon, *NCCC-42 Committee on Swine Nutrition*.

An experiment involving 560 crossbred pigs (28 replications of 4 to 6 pigs/pen) was conducted at 9 stations to assess the effects of dietary levels of DDGS on pig performance from 33 to 121 kg BW and on firmness of carcass fat. Fortified corn-soybean meal diets containing 0, 15, 30 or 45% DDGS were fed in 3 phases. A common source of DDGS (supplied by ADM, Decatur, IL) analyzing 89% DM, 26.3% CP, 0.96% Lys, 0.18% Trp, 9.7% fat, 34.6% NDF, 0.03% Ca, and 0.86% P was used at each station. Diets were formulated to contain 0.83, 0.70, and 0.58% true ileal digestible (TID) Lys during the 3 phases with diets changed at 60 and 91 kg BW, respectively. DDGS replaced corn and soybean meal, and up to 0.22% L-Lys and 0.04% Trp were added to maintain constant TID levels in each phase. At each station, 2 pigs from each pen in 2 replications were killed and a midline backfat core was obtained for fatty acid (FA) analysis and I value. In most cases, there were differences among stations, but station x treatment interactions were few. Gain was linearly reduced ( $P < 0.01$ ) in pigs fed the higher levels of DDGS during phase 1 (950, 964, 921, 920 g), phase 2 (1,001, 982, 957, 959 g), and overall (944, 953, 924, 916 g), but ADFI (2.74, 2.77, 2.69, 2.71 kg) and feed/gain (2.90, 2.91, 2.92, 2.96) were not affected ( $P > 0.05$ ). Backfat was reduced linearly ( $P < 0.05$ ) by DDGS (22.8, 22.7, 21.4, 21.3 mm) but differences in LM area (47.2, 47.4, 46.1, 45.6 cm<sup>2</sup>) and carcass fat-free lean (51.7, 52.2, 52.4, 52.3%) were not detected ( $P > 0.05$ ). Flex measures obtained at 6 stations indicated less firm bellies (linear,  $P < 0.001$ ) as DDGS levels increased (lateral flex: 11.7, 8.6, 8.4, 6.8 cm; vertical flex: 26.0, 27.4, 28.2, 28.9 cm). Saturated and monounsaturated FA in subcutaneous fat decreased ( $P < 0.001$ ) and polyunsaturated FA increased ( $P < 0.001$ ) with increasing DDGS in the diet. Linoleic acid represented 17, 21, 26, and 31% of the total FA, and I values (calculated from the FA data) were 74, 79, 85, and 92 ( $P < 0.001$ ). In this study, feeding diets with 30 or 45% DDGS did not have major effects on pig performance, but resulted in softer bellies.

**Key Words:** pigs, distillers grains, carcass

**139 Using high protein distillers dried grains (HP-DDG) to replace soybean meal in diets for finishing pigs.** R. B. Hinson\*<sup>1</sup>, G. D. Gerlemann<sup>1</sup>, L. Ma<sup>1</sup>, L. Prewitt<sup>2</sup>, and G. L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Agreeco, Chesterfield, MO.

The use of distiller dried grain with solubles (DDGS) in swine finishing diets is typically limited due to the fat and fiber content. Recently

several fractionated processes have been utilized in an effort to provide a more useful co-product for use in swine diets. The objective of this experiment was to evaluate a novel HP-DDG product (44.9% crude protein and 3.71% fat; produced by Buhler Inc.) replacing soybean meal in diets for finishing pigs (58 to 130 kg). A total of 40 individually fed TR-4 x C22 pigs (58 kg) were allotted to one of five treatments in completely randomized block design with eight replicate pens per treatment. Treatments included a corn-soybean meal (control) diet and diets with HP-DDG replacing 33, 66, 66 + tryptophan, or 100% + tryptophan of the soybean meal on a weight basis. All HP-DDG diets contained additional crystalline lysine to provide similar levels of SID lysine in all diets. Pigs were fed from 58 to 130 kg BW in a three phase program (each phase was 21 days). At trial termination, pigs from the corn-SBM control diet and the pigs from the 100% replacement of SBM with HP-DDG were slaughtered for carcass evaluation. For the overall period there were no differences ( $P < 0.05$ ) in ADG (1.15, 1.13, 1.16, 1.12, 1.14 kg/d, respectively), feed intake or feed efficiency (2.90, 2.99, 2.92, 2.96, 2.94, respectively) due to dietary treatment. Similarly, there were no differences ( $P < 0.05$ ) in carcass traits between pigs fed the corn-SBM control diet and those fed the diet where HP-DDG replaced all the soybean meal. This research suggest that this HP-DDG can totally replace SBM in diets for grow-finish (58 – 130 kg) pigs without negative effects on growth performance and carcass quality if the amino acid limitations of HP-DDG are corrected.

**Key Words:** high-protein DDG, pigs, soybean meal

**140 Energy concentration and amino acid digestibility in a novel source of high-protein distillers dried grain fed to pigs.** B. G. Kim\*, G. I. Petersen, and H. H. Stein, *University of Illinois, Urbana*.

A novel source of high-protein distillers dried grains (HP-DDG) has been produced by Buhler Inc. (Minneapolis, MN). This product contains approximately 45% CP, 1.32% Lys, 1.06% Met, 1.69% Thr, 0.25% Trp, and 5,236 kcal GE/kg (as-fed basis). Two experiments were conducted to measure DE and ME and the standardized ileal digestibility (SID) of AA in this product. The DE and ME in HP-DDG and in corn were measured using 16 growing barrows (24.6 ± 1.66 kg BW). A corn-based basal diet and a diet containing 50% corn and 48.2% HP-DDG were formulated. The total collection method and the difference procedure were used. The concentrations of DE and ME in HP-DDG (91.7% DM) were greater ( $P < 0.001$ ) than in corn (89.1% DM; 4,627 vs. 3,565 kcal/kg and 4,303 vs. 3,493 kcal/kg, respectively; as-fed basis). The SID of AA in HP-DDG and in soybean meal (SBM) was determined using 9 barrows (109.8 ± 2.78 kg BW). Pigs were surgically fitted with a T-cannula in the distal ileum. Pigs were allotted to a triplicated 3 x 3 Latin square design with 3 diets and 3 periods per square. Diets based on HP-DDG or SBM as the only source of AA were formulated. An N-free diet was also included to measure basal endogenous losses of AA. The SID of indispensable AA were less ( $P < 0.01$ ) in HP-DDG than in SBM (Arg, 87.5 vs. 93.9%; His, 76.7 vs. 88.7%; Ile, 76.4 vs. 87.5%; Leu, 77.8 vs. 86.8%; Lys, 75.4 vs. 88.4%; Met, 82.8 vs. 88.4%; Phe, 77.9 vs. 87.3%; Thr, 72.5 vs. 83.5%; Trp, 85.1 vs. 91.0%; Val, 73.3 vs. 88.1%). Based on the SID of AA in HP-DDG, limiting AA in a diet based on corn and HP-DDG were calculated. Lysine, Trp, and Thr were identified as the first, the second, and the third limiting AA when HP-DDG was used as a protein source with corn as an energy source for a 50 kg pig. We conclude that HP-DDG has greater energy values for pigs than corn but lower ileal AA digestibility values than SBM.

**Key Words:** high-protein distillers dried grains, nutritional values, pigs

**141 Influence of rapid introduction and removal of dietary corn distillers dried grains with solubles (DDGS) on pig performance and carcass characteristics.** A. M. Hilbrands\*<sup>1</sup>, L. J. Johnston<sup>1</sup>, G. C. Shurson<sup>2</sup>, and I. Kim<sup>2</sup>, <sup>1</sup>University of Minnesota, West Central Research and Outreach Center, Morris, <sup>2</sup>University of Minnesota, St. Paul.

Due to price fluctuation the dietary inclusion of DDGS may only be economical intermittently throughout the growing-finishing period. A study was conducted to determine the effects of rapid introduction and removal of DDGS from growing-finishing pig diets on growth performance and carcass composition. Crossbred pigs (n = 216; BW = 51.3 ± 3.1 kg) were blocked by weight and assigned randomly to one of 24 pens (9 pigs/pen). Pens within a block were assigned randomly to one of 4 dietary treatments fed in 3 phases. Dietary treatments consisted of a corn-soybean meal control (D0), a corn-soybean meal diet containing 20% DDGS fed throughout the study (D20), D20 and D0 diets alternated bi-weekly (D20SW), and a 40% DDGS diet alternated bi-weekly with the D0 diet (D40SW). There were 5 bi-weekly feeding periods with pigs assigned to D20SW and D40SW treatments starting and ending the trial consuming DDGS diets. There were no differences in ADG among treatments but D20SW pigs tended to have heavier final BW (P < 0.09) than D40SW pigs. Pigs assigned to D40SW tended to have lower ADFI (P < 0.07) than D20 pigs. Pigs assigned to D20SW had better gain efficiency (P < 0.05) than D20 pigs. At harvest, D0, D20, and D20SW pigs had heavier HCW (P < 0.01) than D40SW pigs but 10th rib backfat depth, loin eye area and percent carcass lean were not affected by treatment. These results suggest that the rapid inclusion and removal of 20% DDGS from growing-finishing pig diets will not adversely affect pig performance or carcass characteristics but that at 40% DDGS inclusion levels it may reduce ADFI and HCW.

**Table 1. Effects of rapid DDGS inclusion and removal on pig performance and carcass traits**

Trait	D0	D20	D20SW	D40SW	PSE
Initial wt, kg	51.3	51.3	51.3	51.4	0.05
Final wt, kg	112.2 <sup>xy</sup>	112.2 <sup>xy</sup>	113.0 <sup>x</sup>	110.6 <sup>y</sup>	0.62
ADG, kg	0.87	0.87	0.88	0.85	0.009
ADFI, kg	2.70 <sup>xy</sup>	2.75 <sup>x</sup>	2.71 <sup>xy</sup>	2.63 <sup>y</sup>	0.029
G:F	0.323 <sup>ab</sup>	0.317 <sup>a</sup>	0.325 <sup>b</sup>	0.322 <sup>ab</sup>	0.002
HCW, kg	83.8 <sup>a</sup>	83.6 <sup>a</sup>	84.3 <sup>a</sup>	81.1 <sup>b</sup>	0.53
Dressing %	74.8	74.6	74.6	73.8	0.31

<sup>ab</sup> Within a row means without a common superscript differ (P < 0.05). <sup>xy</sup> Within a row means without a common superscript differ (P < 0.10).

**Key Words:** DDGS, growth, pigs

**142 Ethanol corn co-product assessment opportunities and challenges in the swine industry.** B. J. Kerr\*<sup>1</sup>, P. V. Anderson<sup>2</sup>, and G. C. Shurson<sup>3</sup>, <sup>1</sup>USDA-ARS-NSTL, Ames, IA, <sup>2</sup>Iowa State University, Ames, <sup>3</sup>University of Minnesota, St. Paul.

Corn milling for ethanol production has resulted in an increased variety of co-products for use in feed formulation, ranging from a highly digestible feedstuff such as dehulled, degermed corn (8.3% CP, 88% ST, 2.6% TDF, 0.2% EE), to high protein distillers dried grains (44% CP, 7.3% ST, 31% TDF, 2.9% EE), to fibrous corn bran (11% CP, 23% starch, 54% TDF, 5.1% EE). Likewise, distillers dried grains with solubles (DDGS) may have various amounts of oil removed such that the reduced oil DDGS may contain only 3% EE vs. the 11% found in typical DDGS. Empirical methods for determination of energy values are difficult, expensive, and variable. However, estimation of energy values

from regression equations based on nutrient composition varies greatly depending upon which regression equation is used. Likewise, nutrient composition both within and between these co-products varies constantly and substantially depending upon the milling methodology. Results from a recent collaborative effort focusing on in vivo determination of ME content of corn co-products showed that ME ranges from 2,334 to 8,777 kcal/kg. Application of published regression equations to this data set to estimate ME from the analyzed chemical composition resulted in predicted ME values that did not match well with the empirically derived values, bringing into question our ability to accurately predict the energy value of corn co-products. Causes for these discrepancies are not fully understood, but likely include differences in methodology used to determine ME as well as variation in analytical composition of the feed ingredient itself. Lastly, the influence of exogenous enzymes and feed processing on co-product utilization needs to be better understood. In addition, the value of corn co-products as an available P source is poorly understood, and is influenced by processing method and dietary phytase supplementation. Lastly, the influence of processing method, solubles addition, and the interactive effects of fiber on availability of amino acids and other nutrients needs to be determined.

**Key Words:** corn co-products, nutrient availability, prediction equations

**143 Evaluation of distillers dried grains with solubles withdrawal programs on grow-finish pig growth performance and carcass quality.** J. G. Stevens\*, A. P. Schinckel, M. A. Latour, D. Kelly, B. Legan, and B. T. Richert, *Purdue University, West Lafayette, IN.*

Crossbred pigs (N=112; initial BW = 29.0 kg) were blocked by initial BW and sex and assigned to 1 of 7 dietary treatments to assess the impact of removing dried distillers grains w/ solubles (DDGS) and adding fat to the late finish diet on growth and carcass traits. Dietary treatments were: 1) Corn-soybean meal (CS) control d 0-103; 2) 20% DDGS d 0-103; 3, 4, and 5) 20% DDGS d 0-77 and CS or CS+5% Beef tallow (BT) or 5% Choice white grease (CWG) from d 77-103, respectively; 6 and 7) 20% DDGS+5% CWG d 0-77 and CS+5% BT or 5% CWG d 77-103, respectively. All diets were formulated on an equal dig. Lys to calorie ratio and met the minimum digestible amino acid ratios for all diets. Pigs were fed 2 grower diets (G1 d 0-28; G2 d 28-56) and 2 finisher diets (F1 d 56-77; F2 d 77-103). Pigs fed treatment 3 vs pigs fed treatments 4 and 5 tended to have lower F2 ADG (0.898 vs 1.057 and 1.005 kg/d, respectively; P = 0.081) and GF (0.26 vs 0.30 and 0.29, respectively; P = 0.055). No other differences (P > 0.05) were observed for ADG, ADFI, and GF during F2. No differences (P > 0.05) were observed for overall ADG and ADFI across treatments. Overall GF was greater (0.356 vs 0.335, P = 0.031) for treatments 6 and 7 than treatments 4 and 5. No differences were observed for final BW, carcass percent lean, visual 10th rib loin color, marbling, firmness, loin and ham pH, driploss, and Minolta color L\* and color a. Pigs fed treatment 2 compared to treatment 1 had smaller 10th rib LM area (P = 0.081), decreased last rib BF (P = 0.036) and decreased carcass yield (P = 0.034). Pigs fed added fat for the entire grow finish period (treatments 6 and 7) tended to have greater last rib back fat than pigs fed added fat during F2 (treatments 4 and 5) (29.9 mm vs 31.4; P = 0.065). Withdrawing 20% DDGS and adding CWG or BT for the last 26 d had little effect on growth performance or pork quality in grow finish pigs.

**Key Words:** pigs, dried distillers grains with solubles, withdrawal

**144 Inclusion of fat in sow lactation diets containing dry distillers grain with solubles.** L. Greiner<sup>1</sup>, J. Soto\*<sup>1</sup>, G. Allee<sup>2</sup>, and J. Connor<sup>3</sup>, <sup>1</sup>*Innovative Swine Solutions, LLC, Carthage, IL*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*Professional Swine Management, LLC, Carthage, IL*.

An experiment was conducted with 210 multiparous sows (parity 1–6, PIC, Camborough 22, 241.51 ± 47.11 kg) to evaluate the inclusion of fat in diets containing dry distillers grain with solubles (DDGS) on sow and litter performance during a 19 d lactation period and on subsequent reproductive performance. Prior to farrowing, sows were fed a 10% DDGS diet throughout gestation. Sows were randomly allotted to one of three corn soybean meal lactation diets with 20% DDGS formulated to contain different levels (0, 1, and 2%, respectively) of choice white grease (fat). All diets were formulated to be isocaloric 3.46 Mcal ME/kg and contained vitamins and minerals that exceeded recommendations (NRC, 1998). Experimental diets were given to sows from 112 d of pregnancy throughout the 19 d lactation period. Sows were allowed ad-libitum access to feed 2 days after they had completed farrowing. Litters were standardized to average 11.4 pigs within 48 h after farrowing, and sows had free access to feed throughout lactation (17.4 ± 1.4 d). Sows were fed with a computerized feeding system that assured free ad libitum feed intake and allowed the determination of daily individual sow feed intake during the lactation period. During the study, the 2% added fat diet had moderate difficulty flowing from the feed bin. All other diets flowed well from the feed bin. Sow ADFI averaged 6.4, 6.4, and 6.3 kg/d for 0, 1, and 2% fat, respectively, with no differences (P ≥ 0.7) between fat levels. Increasing fat did not alter sow weight loss (–2.1, –1.8, and –2.3 kg, P ≥ .8) or wean to first service interval (6.5, 6.5, and 5.6 days, respectively, P ≥ .4). In addition, piglet average daily gain (.27, .28, and .27 kg/day, respectively) and piglet pre-wean mortality (8, 8.9, and 7.7%) was not affected (P ≥ .8) by the inclusion of fat. In conclusion, the addition of up to 2% fat with 20% DDGS did not provide any additional benefit to the nursing piglet or the sow.

**Key Words:** DDG, sow, lactation

**145 Digestibility of dietary fiber in distillers co-products fed to growing pigs.** P. E. Urriola\*<sup>1</sup>, G. C. Shurson<sup>2</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*University of Minnesota, St. Paul*.

The objective of this research was to measure the apparent ileal (AID) and the apparent total tract digestibility (ATTD) of fiber in different sources of distillers dried grains with solubles (DDGS) and to calculate the fermentability of fiber in DDGS. Ileal digesta and fecal samples from pigs fed diets that each contained 1 of 25 sources of corn DDGS (C-DDGS), 1 source of sorghum DDGS (S-DDGS), 1 source of DDGS produced from a blend of sorghum and corn (SC-DDGS), and 1 source of corn distillers dried grains (DDG) were used. All diets were formulated by mixing DDGS or DDG with sugar, cornstarch, oil, vitamins, and minerals, and DDGS or DDG were the only ingredients that contributed fiber to the diets. Chromic oxide was included in all diets as an indigestible marker. Values for AID and ATTD of fiber were calculated using conventional procedures and fermentation of fiber was calculated by subtracting values for AID from values for ATTD. Fiber was analyzed as total dietary fiber (TDF) in all samples. In a subset of 10 samples, fiber was also analyzed as crude fiber, ADF, NDF, insoluble dietary fiber (IDF), and soluble dietary fiber (SDF). Samples were also analyzed for ether extract, DM, CP, and ash, and the organic residue (OR) was then calculated by subtracting CP, ether extract, ash, and moisture from 100%. Results showed that the AID (23.2 ± 7.3%), ATTD (45.9 ± 9.0%), and fermentation (32.6 ± 12.9%) of TDF differ (P ≤ 0.05) among sources of corn DDGS. The AID of TDF in DDG

(0.73%) was lower (P ≤ 0.01) than in DDGS, but there were no differences in the ATTD of TDF between DDG (43.8%) and DDGS. The AID (64.4 ± 8.3%) and ATTD (91.3 ± 2.8%) of SDF in DDGS were greater than the AID (20.0 ± 9.8%) and ATTD (31.9 ± 15.4%) of IDF. The ATTD of OR in S-DDGS (72.5%) and in SC-DDGS (68.4%) was greater (P ≤ 0.05) than the ATTD of OR in C-DDGS (64.3 ± 12.6%). In conclusion, AID and ATTD of fiber differ among sources of DDGS and those differences may result in differences in the digestibility of energy. The reasons for the differences in digestibility of fiber among DDGS sources are not known.

**Key Words:** distillers dried grains with solubles, fiber, digestibility

**146 Effects of commercial enzymes in diets containing dried distillers' grains with solubles (DDGS) on nursery pig performance.**

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Two experiments were conducted to evaluate the effects of adding commercial carbohydrases to diets containing DDGS on pig performance. In both trials, pig were blocked by weight in a complete randomized-block design. In Exp. 1, 180 pigs (PIC, 9.0 kg BW) were fed a corn-soybean meal-based control diet, diet containing 30% corn DDGS, or the 30% DDGS diet with 0.05% added Easzyzyme, Hemicell-W, or Porzyme. There were 6 pigs/pen and 6 pens/treatment. Overall (d 0 to 27), ADG and G/F were 531, 512, 500, 475, and 521 g/d; and 0.69, 0.67, 0.69, 0.68, and 0.66, respectively. Adding 30% DDGS to the diet did not influence (P > 0.20) performance. Enzyme additions did not improve (P > 0.10) ADG or G/F. In Exp. 2, 350 pigs (11.0 kg BW) were fed one of 10 dietary treatments. Either 15 or 30% DDGS from one of three sources (corn, sorghum A, sorghum B) were added to a corn-soybean meal control diet. For treatments 8, 9, and 10, 0.05% Easzyzyme was added to the 30% DDGS diets. There were 5 pigs/pen and 7 pens/treatment. Overall (d 0 to 21), there were no (P > 0.10) enzyme × DDGS source interactions. Corn DDGS did not influence (P > 0.10) pig performance. Sorghum DDGS tended to increase (P = 0.06) ADFI and reduced (P = 0.04) G:F with no difference between sorghum DDGS sources. Adding enzymes to the 30% DDGS diets did not improve (P > 0.17) performance. In summary, feeding diets with sorghum DDGS resulted in poorer G:F. Adding enzymes to diets containing 30% DDGS did not improve growth performance.

**Table 1. Effects of DDGS with enzymes on nursery pig performance (Exp. 2)**

Grain	DDGS		ADG, g	ADFI, g	G:F
	Level	Enzyme			
Corn	0%	No	476	727	0.66
Corn DDGS	15%	No	461	725	0.64
	30%	No	467	726	0.64
	30%	Yes	467	734	0.64
	30%	Yes	467	734	0.64
Sorghum DDGS Source A	15%	No	487	761	0.64
	30%	No	458	747	0.61
	30%	Yes	445	713	0.62
Sorghum DDGS Source B	15%	No	478	762	0.63
	30%	No	462	763	0.61
	30%	Yes	472	765	0.62

**Key Words:** distillers, enzyme, nursery pig

**147 Amino acid fortified diets for weanling pigs replacing the use of fish meal and whey protein.** S. W. Kim<sup>\*1</sup>, C. M. Ballou<sup>1</sup>, B. J. Min<sup>1</sup>, and R. L. Payne<sup>2</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Evonik-Degussa Corp., Kennesaw, GA.

A total of 160 newly weaned pigs at 21 d of age was used in a randomized block design with 4 treatments, 8 replicates (4 barrow pens and 4 gilt pens) per treatment, and 5 pigs per pen. All diets contained the same amounts of SBM and plasma protein as common protein sources. Treatments with different protein sources were CON (fish meal, and whey protein), FA (supplemental amino acids, and fish meal), WA (supplemental amino acids, and whey protein), and AA (supplemental amino acids). Pigs were fed the assigned experimental diets for 4 wks based on a 2-phase-feeding (Phase 1: wk 1 postwean; Phase 2: wk 2-4 postwean). Supplemental amino acids were Lys, Thr, Trp, Met, Val, and Ile and these amino acids were used to match amounts of standardized ileal digestible Lys (1.34 and 1.19%), Thr (0.93 and 0.80%), Trp (0.26 and 0.24%), Met+Cys (0.68 and 0.64%), Val (0.99 and 0.91%), and Ile (0.78 and 0.76%) among treatment diets for Phase 1 and 2, respectively. Pigs had access to diets and water ad libitum during the entire experimental period. Body weight and feed intake were measured weekly. Analyzed crude protein compositions of CON, FA, WA, and AA were 24.5, 21.5, 22.2, and 20.3% for Phase 1 and 23.6, 18.9, 18.2, and 19.8% for Phase 2, respectively. During week 1, ADG of FA (172.6 g), WA (202.7 g), and AA (182.0 g) were greater ( $P < 0.05$ ) than ADG of CON (114.3 g). However, there were no differences in ADFI among the treatment groups. Gain/feed of FA (0.730), WA (0.836), and AA (0.774) were greater ( $P < 0.05$ ) than that of CON (0.562). During week 2, 3, and 4, there were no differences in ADG, ADFI, and gain/feed among treatment groups. During the entire 4 week period, ADG were 307, 333, 327, and 344 g, ADFI were 526, 540, 556, and 564 g and gain/feed were 0.592, 0.618, 0.590, and 0.614 for CON, FA, WA, and AA, respectively. There were no differences in ADG, ADFI, and gain/feed among treatment groups. Supplemental Lys, Thr, Trp, Met, Val, and Ile successfully replaced the use of fish meal and whey protein without adverse effects on growth performance of pigs at 3-7 wk of age.

**Key Words:** amino acid, fish meal, whey protein

**148 Determining the optimum dietary tryptophan to lysine ratio in growing pigs fed diets formulated with higher levels of the other essential amino acids.** A. D. Quant<sup>\*1</sup>, M. D. Lindemann<sup>1</sup>, G. L. Cromwell<sup>1</sup>, B. J. Kerr<sup>2</sup>, and R. L. Payne<sup>3</sup>, <sup>1</sup>University of Kentucky, Lexington, <sup>2</sup>USDA, Ames, IA, <sup>3</sup>Evonik-Degussa Corporation, Kennesaw, GA.

Studies on amino acid (AA) ratios require the first limiting AA (generally Lys) to be set below the requirement estimate. Graded levels of the AA being investigated are then fed to determine the required ratio. Essential AA (EAA) not under investigation are often set at their presumed requirement ratio relative to that first limiting AA. A 21-d study was conducted to evaluate the optimum standardized ileal digestible (SID) Trp:Lys ratio in 20 to 50 kg pigs fed diets where the EAA not being examined were formulated to 100% of a previously determined Lys requirement (resulting in a presumed greater excess of EAA). Cross-bred pigs ( $n = 120$ ; initial BW:  $24.1 \pm 2.7$  kg) were blocked by BW and gender and allotted to 6 diets with 5 pigs/pen. Diets were formulated to an SID Lys of 0.66% (0.74% total Lys) with the addition of L-Trp to the basal diet to create 6 SID Trp:Lys ratios (13.08, 14.06, 15.04, 17.00, 18.95, and 20.91%). Treatments were designed to bracket the optimum SID Trp:Lys ratio of 15.7% (determined in our previous studies) with 3 diets above and below this ratio. Other EAA were set based on a Lys requirement of 0.905% total Lys. Pigs were allowed ad libitum access to feed and water throughout the study. As SID Trp:Lys ratios increased

from 13.08% to 20.91%, ADG increased (0.429, 0.476, 0.561, 0.714, 0.766, and 0.792 kg/d) linearly ( $P < 0.001$ ) and quadratically ( $P = 0.004$ ), with linear broken-line analysis indicating an optimum SID Trp:Lys ratio of 17.93% ( $P < 0.001$ ). Plasma urea N concentrations decreased (10.62, 9.51, 8.83, 7.93, 8.08, and 8.63 mg/dL) linearly ( $P = 0.011$ ) and quadratically ( $P = 0.015$ ) as SID Trp:Lys ratios increased, displaying an optimum SID Trp:Lys of 16.17% ( $P = 0.009$ ). Based on the average of ADG and PUN optima, the optimum SID Trp:Lys ratio was determined to be 17.05%, which equates to 17.54% on a total AA basis. This ratio was marginally higher than that of previous studies at our station with lower EAA levels suggesting that the optimum ratio may be impacted by the methodology used in these type of studies.

**Key Words:** lysine, pigs, tryptohan

**149 The use of crystalline amino acids in sow lactation diets.** G. L. Allee<sup>\*1</sup>, L. Greiner<sup>2</sup>, J. L. Usry<sup>3</sup>, and N. Williams<sup>4</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Innovative Swine Solutions, Carthage, IL, <sup>3</sup>Ajinomoto Heartland, LLC, Chicago, IL, <sup>4</sup>Pig Improvement Company, Hendersonville, TN.

Two experiments with 328 parity 2 and 3 sows (PIC, Camborough 22,  $191 \pm 21$  kg) were conducted to evaluate the effect of crystalline amino acids inclusion on lactation performance. Sows were randomly allotted to 1 of 5 experimental diets, 4 of which contained different levels of L-lysine.HCl inclusion (0.00, 0.10, 0.20, and 0.30%, respectively), replacing intact lysine, from corn and soybean meal. L-threonine and a methionine source were supplemented in the L-lysine inclusion diets to give the same ratios relative to lysine as in the corn soybean meal (1.05% lysine) control diet. These 4 diets were formulated to have the same total lysine (1.05%) and 3.45 Mcal ME/kg and contained vitamins and minerals that exceeded recommendations (NRC, 1998). The fifth diet (a positive control (PC)) was a corn/soybean meal diet containing 1.15% total lysine. Litter size was standardized within 48 h after farrowing. Sows were fed with a computerized feeding system that allowed true ad libitum consumption after 72 h post farrowing and allowed the collection of daily individual feed intake. Average litter gain was not significantly different ( $P \geq 0.05$ ) 2.38, 2.28, 2.30, 2.49 and 2.34 kg/d when sows were fed PC, 0.00, 0.10, 0.20 and 0.30% L-lysine.HCl, respectively. Increasing L-lysine.HCl inclusion did not affect average daily feed intake (ADFI) which averaged 5.80 kg/d and did not affect ( $P \geq 0.05$ ) sow weight change or subsequent litter size. These studies demonstrate that lactation diets for P-2 and P-3 females can contain up to 0.30% L-lysine.HCl with a supplemental threonine and a methionine source, and have no detrimental effect on litter growth rate, sow weight change or subsequent reproductive performance while decreasing nitrogen excretion.

**Key Words:** sow, amino acids, lysine

**150 The standardized ileal digestible valine to lysine requirement ratio is at least 70% in post-weaned piglets.** J. van Milgen<sup>\*1,2</sup>, R. Barea<sup>1,2</sup>, L. Brossard<sup>1,2</sup>, N. Le Floc<sup>1,2</sup>, D. Melchior<sup>3</sup>, and Y. Primot<sup>3</sup>, <sup>1</sup>INRA, UMR1079, Saint-Gilles, France, <sup>2</sup>Agrocampus Ouest, UMR1079, Rennes, France, <sup>3</sup>AJINOMOTO EUROLYSINE S.A.S., Paris, France.

Improving the balance between amino acids relative to the requirement implies that we need to have accurate knowledge of the requirement of individual amino acids. Although there is relatively little information available concerning the Val requirement in pigs, it is often considered to be a potentially limiting amino acid for growth. The purpose of

this study was to determine the standardized ileal digestible (SID) Val requirement in post-weaned piglets using diets in which the Lys supply is second-limiting (1.0% SID Lys). Three experiments were carried out using individually-housed piglets. The ADFI, ADG, and G:F were used as response criteria during a 3 wk period (approximately 12 to 25 kg BW). The first experiment was conducted to evaluate the response of piglets to an increasing Val supply provided by 2 sources of L-Val differing in degree of purity. Increasing the Val supply from 58 to 66% SID Val:Lys resulted in a linear increase in both ADFI and ADG by 24 and 30%, respectively. No difference was observed between both sources of L-Val. Experiments 2 and 3 were dose-response studies using 5 levels of Val with SID Val:Lys levels ranging from 60 to 80%. The two experiments differed in the supply of branched-chain amino acids (BCAA) other than Val. The SID Ile:Lys and Leu:Lys ratios were respectively 55 and 113% in Exp. 2 and 65 and 166% in Exp. 3. In Exp. 2, the SID Val:Lys requirements for maximizing ADFI, ADG and G:F were respectively 74, 70, and 68% using a linear-plateau model. These values were approximately 5 percentage points higher when a curvilinear-plateau model was used. In Exp. 3, the SID Val:Lys requirements for maximizing ADFI and ADG were 69 and 69%. The F:G ratio was not affected by Val supply. Excess supply of Ile and Leu had a large impact on the depression of ADFI and ADG when Val supply was limiting. At a supply of 60% SID Val:Lys, ADFI and ADG were 88 and 82% of the plateau values in Exp. 2, but only 53 and 42% of the plateau values in Exp. 3. The results of these experiments indicate that the SID Val:Lys is at least 70%, which is slightly higher than the current NRC recommendation of 68%.

**Key Words:** pigs, valine, requirement

**151 Bioefficacy of liquid methionine hydroxy analogue (MHA-FA) compared to DL-methionine based on growth response maximum in pigs.** R. D. Boyd\*<sup>1</sup>, M. E. Johnston<sup>1</sup>, and C. E. Fralick<sup>2</sup>, <sup>1</sup>The Hanor Company, Inc., Franklin, KY, <sup>2</sup>Swine Tek Research, Van Wert, OH.

The basis for yet another assay to compare liquid MHA-FA as a substrate for methionine synthesis with DL-methionine (DLM) is that the NRC (1998) and CVB (2003) have drawn different conclusions with respect to relative molar equivalence of DLM and MHA-FA. 880 PIC Camborough x TR-4 castrates were used in a 28 d growth assay (10 pigs/pen). Pigs (initial BW 26.2±1.1 kg) were blocked by weight and randomly allotted to a basal diet plus 5 diets for each form (8 pens/diet). Equimolar additions of DLM standard and MHA-FA substrate were formed by blending basal (0.46% SID M+C:Lysine) and high DLM (0.66%) or high MHA-FA (0.66%). Diets consisted of corn, soya, whey and plasma. Molar equivalence was confirmed by analysis. SID Lysine was set at 1.10% for each diet, which is 95% of asymptote. Daily gain and G:F averaged 1.054±0.014 kg/d and 0.550±0.005 respectively, for the 28 d assay. Daily gain and G:F improved with increasing dose of each form (P<0.10). A form × level interaction was observed for G:F ratio (P<0.01), thus the need for separate curves by source. Gain (P<0.13) and feed intake (P<0.33) did not exhibit an interaction. G:F ratio exhibited acceptable fit for comparison ( $R^2 \geq 0.717$ ). Linear response slope for MHA-FA (0.45-0.55 SID M+C:Lysine) was 0.630 compared to DLM, which agrees with recent N-retention estimates. Response maximum (R-max) or asymptote was achieved for DLM at a 0.535 SID M+C:Lysine ratio (G:F, 0.553). R-max for MHA-FA was achieved with a 0.620 SID M+C:Lysine ratio (G:F, 0.556). Thus, a 0.560 SID M+C:Lysine ratio was required for MHA-FA to achieve G:F response equivalence to the 0.535 ratio for DLM. Response to DLM fit a quadratic function (P<0.01) for both ADG and G:F. We conclude

that SID M+C:Lysine response asymptote is 0.545 (ADG, 0.535; G:F, 0.553) for high lean growth pigs (26 to 56 kg phase) and that MHA-FA is not equivalent to DLM on a molar basis.

**Key Words:** pigs, methionine, methionine hydroxy-analogue

**152 Growth performance of 20-to 50-kilogram pigs fed low crude protein diets supplemented with L-Histidine, L-Cystine, and Glycine.** S. Powell\*<sup>1</sup>, J. Greely<sup>1</sup>, T. Bidner<sup>1</sup>, L. Southern<sup>1</sup>, and R. Payne<sup>2</sup>, <sup>1</sup>LSU Agricultural Center, Baton Rouge, LA, <sup>2</sup>Evonik-Degussa Corp., Kennesaw, GA.

In previous studies, grower pigs (20 to 50 kg) fed a low CP corn soybean (C-SBM) diet containing 0.34% supplemental Lys and also supplemented with Thr, Met, and Trp had reduced growth performance compared with pigs fed a positive control (PC) C-SBM diet with no supplemental AA. Growth performance was improved with Ile and Val supplementation; however, GF was lower than that of pigs fed the PC diet. Therefore, experiments (Exp) were conducted to investigate the effect of supplemental His, Cys, or Gly to low CP C-SBM diets for grower pigs. All diets were formulated to 0.83% standardized ileal digestible Lys. Treatments had 4 to 6 reps with 4 to 5 crossbred pigs per pen. Each Exp lasted 28 d and plasma urea nitrogen (PUN) was determined at the start and end of each Exp. Treatments were considered different at P < 0.1. Experiment 1 had 4 treatments: 1) C-SBM PC; 2) low CP C-SBM with 0.34% Lys + Met, Thr, and Trp; 3) Diet 2 + 0.063 % Ile + 0.103% Val; 4) Diet 3 + 0.05% His. Pigs fed Diet 2 had lower ADG than pigs fed Diet 1 (656 vs 743 g/d) and pigs fed Diet 4 had increased ADFI compared with pigs fed Diet 1 (1,645 vs 1,740 g/d). Pigs fed Diets 2 and 4 had lower GF than pigs fed Diet 1 (0.418 and 0.413 vs 0.455 g/g); also PUN was decreased in all diets compared with pigs fed Diet 1 (3.1, 3.4, 2.9 vs 9.9 mg/dL). In Exp 2, 5 treatments were utilized: Diets 1, 2, and 3 were identical to Exp 1; Diet 4) Diet 2 with Met:Cys 50:50 (weight basis), 5) Diet 2 with 0.224% Gly. Similar to Exp 1, pigs fed Diet 2 had lower ADG compared with those fed Diet 1 (650 vs 703 g/d). Pigs fed Diets 3 and 5 had higher ADFI compared with those fed Diet 1 (1,609 and 1,646 vs 1,510 g/d), and GF was lower for pigs fed all diets compared with pigs fed Diet 1 (0.426, 0.426, 0.433, 0.428 vs 0.467 g/g). Also, PUN was decreased in all diets compared with pigs fed Diet 1 (4.2, 4.5, 4.2, 5.17 vs 11.6 mg/dL). The results of these Exp indicate that supplementing His, Cys, and Gly to a low CP C-SBM diet with 0.34% Lys + Met, Thr, Trp, Ile, and Val does not restore feed efficiency similar to that of pigs fed a PC diet with no Lys supplementation.

**Key Words:** pigs, low crude protein, amino acids

**153 Growth performance of 20-to 50-kilogram pigs fed low crude protein diets supplemented with Glycine and L-Arginine.** S. Powell\*<sup>1</sup>, T. Bidner<sup>1</sup>, L. Southern<sup>1</sup>, and R. Payne<sup>2</sup>, <sup>1</sup>LSU Agricultural Center, Baton Rouge, LA, <sup>2</sup>Evonik-Degussa Corp., Kennesaw, GA.

In previous studies, grower pigs (20 to 50 kg) fed a low CP corn soybean (C-SBM) diet containing 0.34% supplemental Lys and also supplemented with Thr, Met, and Trp had reduced growth performance compared with pigs fed a positive control (PC) C-SBM diet with no supplemental AA. Growth performance was improved with Ile and Val supplementation; however, GF was lower than that of pigs fed a C-SBM diet with no AA supplementation. Supplementation with His, Cys, and Gly was not completely effective. Therefore, 2 experiments (Exp) were conducted to investigate the effect of supplementation of Gly and Arg to low CP C-SBM diets for grower pigs. All diets were formulated to

0.83% standardized ileal digestible Lys. Treatments had 4 to 5 reps with 4 crossbred barrows or gilts per pen. Each Exp lasted 28 d and plasma urea nitrogen (PUN) was determined at the start and end of each Exp. Treatments were considered different at  $P < 0.1$ . Experiment 1 had 5 treatments: 1) C-SBM PC; 2) low CP C-SBM with 0.34% Lys + Met, Thr, and Trp; 3) Diet 2 + 0.063 % Ile + 0.103% Val; 4) Diet 3 + 0.52% Gly; 5) Diet 3 + 1.019% Glu. Pigs fed Diets 2 and 5 had lower ADG (642 and 640 vs 689 g/d) and GF (0.443 and 0.449 vs 0.480 g/g) than pigs fed Diet 1, while PUN was decreased in all diets compared with pigs fed Diet 1 (4.7, 4.5, 5.1, 4.8 vs 12.0 mg/dL). In Exp 2, 5 treatments were used: 1) C-SBM PC; 2) C-SBM with 0.34% Lys + Met, Thr, Trp, Ile, and Val; 3) Diet 2 + 0.52% Gly; 4) Diet 2 + 0.48% Arg; 5) Diet 2 + 0.52% Gly + 0.48% Arg. There was no difference in ADG or ADFI in pigs fed all diets compared with Diet 1; however, GF was lower for pigs fed Diet 4 compared with pigs fed Diet 1 (0.386 vs 0.448 g/g). Also, PUN was decreased in all diets compared with pigs fed Diet 1 (6.6, 7.5, 6.6, 8.2 vs 13.1 mg/dL). The results of these Exp indicate that supplementing Gly and L-Arg together to a low CP C-SBM diet with 0.34% Lys + Met, Thr, Trp, Ile and Val restored the decrease in GF caused by the addition of Arg to the diet.

**Key Words:** pigs, low crude protein, amino acids

**154 Impact of dietary energy level and ractopamine on growth performance, carcass characteristics, and meat quality of finishing pigs.** R. B. Hinson<sup>\*1</sup>, B. R. Wiegand<sup>1</sup>, M. J. Ritter<sup>2</sup>, S. N. Carr<sup>2</sup>, and G. L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Seventy-two TR-4 × C22 barrows (Initial BW = 99.8 kg) reared in individual pens were allotted to one of 6 dietary treatments in a 2 × 3 factorial design with 2 levels of ractopamine (RAC, 0 and 7.4 ppm, Paylean<sup>®</sup>, Elanco Animal Health) and 3 levels of dietary energy (High: 3,538 kcal ME, Medium: 3,369 kcal ME, Low: 3,318 kcal ME) to determine the effects of the feeding of RAC and dietary energy levels on performance, carcass characteristics, and meat quality. High energy diets were corn-SBM with 4% added fat, medium energy diets were corn-SBM with 0.5% added fat, and low energy diets were corn-SBM with 0.5% added fat and 15% wheat middlings (WM). Diets within RAC levels were formulated to contain the same g SID Lys:ME (0 ppm: 1.82, 7.4 ppm: 2.65). Individual pig weights and feed disappearance were recorded at the beginning and conclusion of the study. On d 21, pigs were harvested for determination of carcass characteristics and meat quality. No RAC × energy level interactions were observed for any parameters of interest. Final BW (125.2 vs. 121.1 kg), ADG (1.2 vs. 1.0 kg/d), and F:G (2.57 vs. 3.30) were improved ( $P < 0.001$ ) with the feeding of RAC. The feeding of the low energy diets reduced ( $P < 0.001$ ) final BW and ADG when compared to the high energy diets. Feed:Gain was impaired ( $P < 0.002$ ) when the medium and low energy diets were compared to the high. Feeding RAC increased ( $P < 0.05$ ) HCW (93.6 vs. 89.9 kg) and LEA (51.2 vs. 44.2 cm<sup>2</sup>). Loin pH decline was reduced ( $P < 0.05$ ) with the feeding of RAC. The feeding of the low energy diets reduced ( $P < 0.001$ ) HCW when compared to the high and medium energy diets and reduced ( $P < 0.03$ ) 10th rib BF when compared to the high energy diet. These data suggest that the feeding of RAC effectively improved performance and carcass characteristics while having little to no detrimental effects on meat quality. Reductions in energy content of the diet by adding 15% WM resulted in reductions in ADG, F:G, and 10th rib BF. There were no RAC × energy level interactions, which indicate that the improvements resulting from RAC are present, regardless of energy level of the diet.

**Key Words:** pigs, ractopamine, dietary energy

**155 Effects of increasing standardized ileal digestible lysine to metabolizable energy ratio on performance of 55 to 80 kg gilts in a commercial finishing environment.** N. W. Shelton<sup>\*</sup>, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. L. Nelssen, and J. M. DeRouchey, Kansas State University, Manhattan.

A 28-d growth trial was conducted to estimate the lysine requirement for PIC (1050 × 337) gilts from 55 to 80 kg. A total of 1,092 gilts (initially 55.2 kg) were allotted to 1 of 6 diets with standardized ileal digestible (SID) lysine/ME ratios of 1.89, 2.12, 2.35, 2.58, 2.81, and 3.04 g/Mcal. All diets contained 0.15% L-lysine HCl and 3% choice white grease and were formulated to meet or exceed all other requirements as recommended by NRC (1998). Desired lysine levels were achieved by altering the corn and soybean meal levels in the diet. Dietary total lysine levels were 0.75, 0.84, 0.92, 1.01, 1.10, and 1.19%. Seven replicate pens per treatment were used with approximately 26 pigs per pen. Both ADG (0.90, 0.89, 0.95, 0.97, 0.98, and 0.96 kg/d; SE=0.015) and G:F (0.42, 0.42, 0.44, 0.46, 0.45, and 0.46; SE=0.008) improved (linear,  $P < 0.001$ ) as SID lysine/ME ratio increased, with little difference at levels above 2.58 g/Mcal. As the SID lysine/ME ratio increased, ADFI (2.14, 2.10, 2.16, 2.11, 2.19, and 2.11 kg/d; SE=0.043) was not influenced ( $P > 0.70$ ). Daily SID lysine intake (14.1, 15.6, 17.8, 19.0, 21.5, and 22.3 g/d; SE=0.365) and SID lysine intake per kg of gain (15.7, 17.5, 18.7, 19.6, 22.0, and 23.2 g; SE=0.352) increased (linear,  $P < 0.001$ ) as lysine level increased in the diet. In summary, gilts in this trial required approximately 20 g SID lysine per kg of gain and 2.58 g of SID lysine per Mcal of ME for optimal performance from 55 to 80 kg.

**Key Words:** lysine, growing pigs, growth

**156 Evaluation of the prediction of the net energy content of canola meal and full-fat canola seeds in growing pigs.** C. A. Montoya<sup>\*</sup>, K. Neufeld, P. Kish, and P. Leterme, Prairie Swine Centre Inc., Saskatoon, SK, Canada.

Currently, canola meal (CM) is not used to its full potential in swine nutrition, due to a lack of confidence in its nutritional quality, namely its net energy (NE) content. It is perceived as a poor energy source because it has a low oil content and high protein and fibre contents. Full-fat canola seeds (FFCS) could provide the required energy but here, again, little information is available on their digestible energy (DE) or NE content. This study aimed to evaluate the validity of the NE content of CM and FFCS by measuring the growth rate of pigs and the feed conversion ratio of diets based on these canola products and formulated with the NE system. The DE content of the canola products was first measured during a digestibility trial where the CM or FFCS were mixed with a basal diet (2/3 of the basal diet and 1/3 of CM or FFCS/kg). A total of 18 growing pigs (36 kg; 6/treatment) were kept in individual metabolic cages for 18 d and their feces were totally collected for the last 10 d. The NE content was estimated by means of a prediction equation based on the DE content and chemical composition of the feedstuffs. The DE and NE content of CM and FFCS obtained was as follows: 3.51 and 4.99 Mcal DE/kg DM and 2.41 and 3.53 Mcal NE/kg, respectively. Two separate growing studies were then conducted with a total of 72 growing pigs (initial bodyweight: 30 kg) for 35 d. The pigs were fed diets containing barley, wheat, soybean meal and graded levels of either FFCS (0, 5, 10 and 15 %) or CM (0, 7.5, 15 and 22.5 %). Each diet was tested on 18 growing pigs (9 females and 9 males). No difference in average daily gain or feed conversion ratio was observed between the treatments, whatever the canola product. In conclusion, the values of NE content obtained here for CM and FFCS seem to be correctly

estimated. Moreover, growing pigs tolerate diets containing up to 22.5 and 15 % of CM and FFCS, respectively.

**Key Words:** canola meal, pig, energy

**157 Efficacy of different porcine circovirus vaccination regimens on pig performance.** B. E. Bass\*<sup>1</sup>, J. W. Frank<sup>1</sup>, Z. B. Johnson<sup>1</sup>, C. V. Maxwell<sup>1</sup>, and P. R. Dubois<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Cargill Pork, Wichita, KS.

An experiment was conducted to evaluate the efficacy of different circovirus (PCV) vaccination regimens on the performance of pigs from nursery to slaughter. This study was completed in the University of Arkansas Swine Research herd which had no previous clinical signs of PCV. For the nursery phase, 232 pigs were weaned at an average of 20.9 ± 0.6 d of age (BW = 6.6 kg) and penned in groups of 6-7 pigs/pen in an offsite nursery facility. Pigs were randomly assigned to one of four treatments and provided common diets and water ad libitum through the study. Treatment groups (TRT) were: 1) No vaccination; 2) 1.0 ml IM injection of Boehringer Ingelheim CircoFLEX™ at weaning; 3) 0.5 ml IM injection of Boehringer Ingelheim CircoFLEX™ at weaning and a 0.5 ml IM injection 3 weeks later; and 4) 2.0 ml IM injection of Intervet Circumvent™ PCV at weaning and a 2.0 ml IM injection 3 weeks later. At the end of the nursery phase, 216 pigs (54 pigs/treatment) were transported to a grow-finish facility. Blood samples were drawn at 4, 10, 14, and 18 weeks of age to test for PCV titers. No significant differences in ADG, ADFI, or G:F were observed during the nursery period. Overall grow-finish ADG was greater for all vaccinated pigs compared to TRT1 (P = 0.01). Final BW for TRT1 through 4 were 122.6, 127.5, 125.9, and 126.3 kg, respectively (P = 0.02). There were no significant differences in ADFI or G:F during the grow-finish period. Carcass weights were increased an average of 4.5 kg in all vaccinated groups compared to TRT1 (P < 0.05); however, there were no differences in lean yield. Pigs that tested positive for PCV titers at week 14 had decreased ADG and BW at the end of the grow-finish period (P = 0.04) compared to pigs that tested negative. Additionally, TRT2 through 4 reduced the number of pigs with positive titers at weeks 14 and 18 compared to TRT1 (P < 0.01). Thus, even in an experimental herd with no previously known PCV associated disease, vaccination greatly improved overall ADG, BW, and carcass weight.

**Key Words:** pig, circovirus, vaccine

**158 Eicosapentaenoic and docosahexaenoic acid modulate the inflammatory response in porcine cartilage explants.** C. I. Robison and M. W. Orth\*, Michigan State University, East Lansing.

Clinical studies have demonstrated that omega-3 polyunsaturated fatty acids can mitigate the inflammatory response that occurs with arthritis. The objective of this study was to characterize the effects of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) on indices of cartilage inflammation in porcine IL-1 beta (pIL-1) stimulated porcine articular cartilage explants. Three experiments were conducted. For each experiment, explants were harvested from the humeral-ulnar joints of 8 Yorkshire × Landrace gilts. Explants were allocated to culture plates at 2 discs/well with 4 wells/treatment/gilt and cultured in 1 mL of medium for 24 h with 10% serum. Cartilage was then washed in phosphate buffered saline and treated as follows for experiment (EXP

1: 100 ug/mL linolenic acid (LA; control), 93.75 ug/mL LA and 6.25 ug/mL EPA, 87.5 ug/mL LA and 12.5 ug/mL EPA, 81.25 ug/mL LA and 18.75 ug/mL EPA, and 75 ug/mL LA and 25 ug/mL EPA. At 48 and 72 h, 1 mL of treatment media containing 5 ng/ml of pIL-1 was added to each well. At 48, 72 and 96 h, media were removed from each well and reserved for analysis. Media were analyzed for proteoglycan (PG), nitric oxide (NO), and prostaglandin E2 (PGE2) concentrations. In EXP 1, the 6.25, 12.5 and 25 EPA treatments decreased PG release relative to the other treatments at 72 h (P<0.01). NO release was lower in all the EPA treatments compared to the 100 LA at 72 h (P<0.05). PGE2 release in the 12.5 and 25 EPA was not different from 100 LA (P<0.05). EXP 2 followed the same protocol, but DHA replaced EPA. PG and NO release were decreased at 72 h in the 12.5, 18.75 and 25 DHA treatments (P<0.05). PGE2 release was higher in 100 LA when compared to treatments containing DHA (P<0.01). EXP 3 used a combination of EPA and DHA. PG release at 72 h was lower in the 18.75 EPA/6.25 DHA, 6.25 EPA/18.75 DHA, and 25 DHA compared to other treatments (P<0.01). All treatments reduced NO and PGE2 release compared to 100 LA (P<0.05). The 25 DHA decreased NO release by 58% and PG release by 35%. These data demonstrate that EPA and DHA can mitigate the inflammatory response in cartilage but may have some unique modes of action.

**Key Words:** cartilage, EPA, DHA

**159 Effect of dam parity on litter performance and passive immunity.** E. E. Carney\*, H. Tran, J. W. Bundy, R. Moreno, M. W. Anderson, J. M. Perkins, D. E. Reese, P. S. Miller, and T. E. Burkey, University of Nebraska, Lincoln.

Evidence suggests that progeny health status may be affected by dam parity. The objective of this experiment was to evaluate litter performance and the production and passive transfer of immunoglobulins (Ig) in first parity (P1) compared to fourth parity (P4) dams. Litter performance was recorded for P1 (n = 19) and P4 (n = 24) dams including: Number of pigs/litter (total born, born live, stillbirths, mummified fetuses, pigs weaned, and pre-weaning mortality), litter weight at birth (LBW), and litter weight at weaning (d 19). Individual piglet BW were recorded on d 0, 7, 14, and 19. In order to monitor transfer of passive immunity, blood samples were collected from all dams on d 90 and 114 of gestation and following parturition (d 0). Blood samples were collected from each litter (n = 6 pigs per litter) on d 1, 7, and 14. Colostrum (d 0) and mid- and late-lactation milk samples (d 7 and 14, respectively) were obtained from each dam. Serum IgG and IgA concentrations were quantified from all samples via ELISA. With respect to litter performance, P4 dams tended (P = 0.10) to have a greater LBW compared to P1 dams. In addition, across all timepoints, P4 progeny had greater (P < 0.0005) BW compared to P1 dams (4.03 vs. 3.40 ± 0.1 kg, respectively for P4 and P1 progeny). No effects of dam parity were observed on circulating Ig in dams during gestation or at parturition. However, concentrations of IgA tended (P = 0.09) to be greater for P4 compared to P1 dams in samples of colostrum and milk. Serum IgG concentrations were greater (P < 0.02) for P4 compared to P1 progeny when IgG concentrations were averaged across all timepoints (16.1 vs. 14.9 ± 0.4 mg/mL, respectively for P4 and P1 progeny). These results suggest that litter performance and passive immunity may be affected by dam parity.

**Key Words:** dam parity, pigs, passive immunity

**160 Growth performance of pigs farrowed in indoor versus outdoor management systems and weaned into an indoor, off-site nursery.** E. Davis\*<sup>1</sup>, C. V. Maxwell<sup>2</sup>, J. D. Spencer<sup>3</sup>, R. L. Moser<sup>3</sup>, J. Rehberger<sup>1</sup>, and T. Rehberger<sup>1</sup>, <sup>1</sup>Agtech Products, Inc., Waukesha, WI, <sup>2</sup>University of Arkansas, Fayetteville, <sup>3</sup>JBS United, Inc., Sheridan, IN.

Two swine herds of similar genetics (PIC C-22 × PIC 280) were selected to evaluate the effects of indoor and outdoor management during the pre-weaning period on growth performance in the nursery. Pigs were farrowed in a conventional, confinement facility located in Sheridan, IN and in an outdoor pasture facility in Springfield, CO. Pigs were weaned from both locations simultaneously at 19 ± 2 d of age and averaging 5.5 kg BW, and were transported to an off-site nursery facility at the University of Arkansas that was cleaned and disinfected. Upon arrival, pigs from each facility were moved into separate rooms to minimize exposure between the two groups, with separate management personnel for each group. Pigs were blocked by BW, penned in groups of seven, and fed common Phase 1 (d 0 to 14), Phase 2 (d 14 to 28), and Phase 3 (d 28 to 42) diets. Pigs farrowed in outdoor facilities had greater ( $P \leq 0.01$ ) ADG and ADFI during Phase 1, Phase 2, and the overall nursery period. Gain:feed did not differ between the treatment groups during any phase of the trial. Pigs farrowed outdoors had greater ( $P = 0.04$ ) BW and were 2.1 kg heavier at the end of the trial. An additional subset of 12 pigs (six from each treatment) was weighed on d 3 after weaning (d 0). The six pigs farrowed outdoors tended to have greater ( $P \leq 0.08$ ) ADG (0.24 vs. 0.15 ± 0.04 kg/d) compared to the six pigs farrowed indoors. These data indicate that pigs farrowed in an outdoor management system and weaned to an indoor facility begin to gain BW more rapidly and maintain greater rates of gain during the nursery period than pigs farrowed in indoor facilities.

**Table 1. Nursery growth performance of pigs farrowed in indoor and outdoor facilities.**

	Indoor	Outdoor	SEM	P =
Initial BW, kg	5.7	5.2	0.3	0.16
d 42 BW, kg	22.9	25.0	0.7	0.04
d 0 to 42 ADG, g	417	477	13	0.01
d 0 to 42 ADFI, g	613	703	20	0.01
d 0 to 42 G:F	0.71	0.70	0.01	0.70

**Key Words:** swine, growth, weaning

**161 The use of ractopamine to enhance the environmental sustainability of pork production.** K. A. Ross\*<sup>1,2</sup>, A. D. Beaulieu<sup>1</sup>, J. Merrill<sup>3</sup>, G. Vessie<sup>3</sup>, and J. F. Patience<sup>1,4</sup>, <sup>1</sup>Prairie Swine Centre Inc., Saskatoon, SK, Canada, <sup>2</sup>University of Saskatchewan, Saskatoon, SK, Canada, <sup>3</sup>Elanco Animal Health, Guelph, ON, Canada, <sup>4</sup>Iowa State University, Ames.

This experiment was conducted to determine if ractopamine HCl (RAC) can increase nutrient utilization and decrease water use in hog operations. This experiment combined growth (GEXP) and metabolism (MEXP) experiments using 9 dietary treatments (trt) arranged as a 3 × 3 factorial: 3 levels of RAC (0, 5 & 10 ppm) and 3 standardized ileal digestible LYS:DE ratios (1.75, 2.25 & 2.75 g/Mcal DE). GEXP utilized a comparative slaughter technique which consisted of 120 barrows (initial BW 95±3 kg) including 12 assigned to an initial slaughter group; the remaining pigs were slaughtered at 108 (n=6/trt) or 120 kg (n=6/trt). Growth performance and nutrient retention were determined. The 15d MEXP consisted of 54 pigs (initial BW 95±3 kg; n=6/trt). Growth performance,

feed and water intake and urine and fecal outputs were measured. In GEXP, RAC had no effect on ADG, ADFI or G: F ( $P > 0.10$ ). Increasing LYS improved G: F (0.35, 0.35 and 0.39;  $P < 0.05$ ), but not ADG or ADFI ( $P > 0.10$ ). Crude protein deposition rates tended to increase (162, 185 & 189 g/d for 0, 5 & 10 ppm RAC;  $P < 0.12$ ) and water deposition (466, 609 & 573 g/d;  $P < 0.05$ ) rates increased, while lipid deposition (620, 462 & 542 g/d) tended to decrease with RAC inclusion ( $P < 0.10$ ). Nitrogen (N) retention tended to increase (29, 32 and 34 %;  $P < 0.11$ ). Pigs fed higher LYS concentrations had improved N retention (26, 29 & 32 g/d;  $P < 0.05$ ) but not when expressed as a % of intake ( $P > 0.10$ ). In MEXP, higher levels of RAC and LYS improved ADG (1.09, 1.27 & 1.25 for RAC; 1.13, 1.27 & 1.21 for LYS;  $P < 0.05$ ) and G: F (0.34, 0.39 & 0.41 for RAC; 0.35, 0.40 & 0.40 for LYS;  $P < 0.0001$ ). RAC decreased water intake (8.3, 7.9 & 7.3 l/d;  $P < 0.05$ .) and urine output (3.5, 3.2 & 2.9 l/d;  $P < 0.05$ ). LYS had no effect on water balance ( $P > 0.10$ ). RAC may reduce the environmental footprint of pork production through improved nutrient utilization and reduced water requirements.

**Key Words:** swine, ractopamine, environment

**162 Effects of EcoCare® Feed on the mass balance of N and P during the swine finishing phase.** T. Walraven\*<sup>1</sup>, S. D. Carter<sup>1</sup>, M. Lachmann<sup>1</sup>, J. Bundy<sup>1</sup>, J. Jarrett<sup>1</sup>, and B. De Rodas<sup>2</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Land O'Lakes Purina Feed, Gray Summit, MO.

Eighty crossbred (D × (L × Y)) pigs (30 kg BW) were used to determine the effects of EcoCare® Feed (Land O'Lakes Purina Feed) on the mass balance of N and P during a 122-d finishing period. Pigs were blocked by BW and sex, and randomly allotted to 1 of 2 dietary treatments. Pigs were housed in an environmentally-controlled building with 4 identical rooms (20 pigs/room, 2 rooms/trt). Each room contained a shallow pit, pull plug system. A fortified corn-soybean meal-based diet served as the control (20.1, 19.3, 17.9, 16.5, 15.1, 13.7% CP; 0.37, 0.34, 0.31, 0.29, 0.27, 0.25% available P for phases 1 to 6, respectively). The test diet (EcoCare®, EC) was similar to the control diet except that CP was reduced by 2.6% units and available P by 0.11% units; with additions of Lys, Thr, Met, EC Pak (containing phytase) and EC premix. The estimation of mass balance, on a per pig basis, assumed that N and P entered the finisher via the feed and pigs, and exited via the slurry, exhaust air, and pigs. On d 0 and 122, 6 and 24 pigs (6/room), respectively, were ground to estimate initial and final body composition. Feed intake and composition were used to estimate N and P entering via feed. Slurry volume and composition, and NH<sub>3</sub>-N emission were used to estimate N and P exiting via slurry and air. The amount of N (0.64 kg) and P (0.11 kg) entering via pigs was similar ( $P > 0.10$ ). However, N (7.4 vs. 6.3 kg) and P (1.6 vs. 1.3 kg) in the feed were reduced ( $P < 0.04$ ) for the EC diet. Thus, EC reduced ( $P < 0.03$ ) total N (8.1 vs. 7.0 kg) and P (1.7 vs. 1.4 kg) entering by 13 and 20%, respectively. EC tended ( $P < 0.09$ ) to increase the amount of N (3.42 vs. 3.44 kg) and P (0.71 vs. 0.72 kg) exiting via the pigs. However, N (4.2 vs. 3.1 kg) and P (1.02 vs. 0.68 kg) exiting via slurry were reduced ( $P < 0.02$ ) for pigs fed EC. Also, EC reduced ( $P < 0.03$ ) NH<sub>3</sub>-N (0.58 vs. 0.35 kg) in exhaust air. Thus, EC reduced ( $P < 0.03$ ) total N (8.2 vs. 6.9 kg) and P (1.7 vs. 1.4 kg) exiting by 16 and 20%, respectively. The proportion of N and P entering the finisher that exited via the pigs increased from 42 to 49% for N and 41 to 52% for P for pigs fed EC compared with those fed the control.

**Key Words:** pig, nutrient, mass balance

**163 Effects of high levels of distillers dried grains with solubles (DDGS) and enzymes on growth performance and carcass traits of grow-finish pigs.** J. J. Jacela\*<sup>1</sup>, S. S. Dritz<sup>1</sup>, M. D. Tokach<sup>1</sup>, J. M. DeRouchey<sup>1</sup>, R. D. Goodband<sup>1</sup>, J. L. Nelssen<sup>1</sup>, and K. J. Prusa<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Iowa State University, Ames.

A total of 1,032 pigs (BW=46 kg) were used in a 90-d study to determine the effects of high levels of DDGS and enzymes on growth and carcass traits. Pigs were blocked by BW and randomly allotted to 1 of 7 dietary treatments with 6 pens per treatment. Control diet had 30% DDGS. Remaining treatments were arranged in a 2 × 3 factorial based on DDGS level (45 or 60%) and enzyme used (none, product A, or product B). Enzymes were proprietary enzymes for use in DDGS diets. Pigs on the 60% DDGS treatment were fed 45% DDGS for the first 2 wk of the trial. The 4 heaviest pigs from each pen were sold at d 78 and DDGS levels in all treatments were reduced to 20% until d 90. Pigs were weighed and feed intake were determined every 2 wk to calculate ADG, ADFI, and G:F. Overall (d 0 to 90), enzyme supplementation did not affect ADG (P>0.24), ADFI (P>0.30), or G:F (P>0.52). From d 0 to 78; regardless of enzyme treatment, ADG decreased (linear; P<0.05) as DDGS increased (856, 833, and 825 g/d) due to the reduction (quadratic; P<0.04) in ADFI (2.32, 2.21, and 2.20 kg). After topping and adding Paylean® to the diets at d 78, ADFI tended to increase (linear; P<0.06) in pigs previously fed 45 and 60% DDGS (2.77, 2.98, and 2.98 kg). The decreased ADFI from d 0 to 78 led to an overall ADFI reduction (linear; P<0.04) as DDGS increased but did not affect (P>0.17) overall ADG (869, 854, 849 g), G:F (0.37, 0.37, and 0.37) or final BW (122.9, 121.9, 121.9 kg). There were no differences in carcass weight and yield (P>0.65); or in backfat, loin depth, percent lean, and FFLI (P>0.38) after adjusting to a common carcass weight. Increasing DDGS increased (linear; P<0.01) belly fat iodine value (IV) (77.2, 83.7, 87.3 g/100 g). This study shows that up to 60% DDGS may be added to pig diets without negatively affecting growth or carcass traits compared to 30% DDGS when levels are reduced to 20% for 12 d before market; however, fat IV will increase.

**Key Words:** enzyme, DDGS, swine

**164 Effect of phytase and xylanase supplementation or particle size on nutrient digestibility of diets containing distillers dried grains with solubles (DDGS) co-fermented from wheat and corn in cannulated grower pigs.** J. Yanez\*<sup>1,2</sup>, E. Beltranena<sup>3</sup>, and R. T. Zijlstra<sup>1</sup>, <sup>1</sup>University of Alberta, Edmonton, Alberta, Canada, <sup>2</sup>Universidad Autónoma de Baja California, Mexicali, México, <sup>3</sup>Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada.

Nutrient digestibility in DDGS is limited by physical constraints such as particle size and biochemical limitations such as phytate and fiber (arabinoxylan). To determine their separate effects, nutrient digestibility was studied in finely ground DDGS (383 µm) supplemented with phytase (0 or 250 units/kg of feed) and xylanase (0 or 4,000 units/kg of feed) in a 2 × 2 factorial arrangement, in unground DDGS (517 µm), and an N-free diet in a 6 × 6 Latin square. Co-fermented wheat and corn DDGS contained 8.6% moisture, 31.0% CP, 1.04% Lys, 8.0% ether extract, 2.0% starch, 40% NDF, and 0.85% P (DM basis). Diets contained 43.7% DDGS as the sole source of AA; the N-free diet served to subtract basal endogenous AA losses and as control for energy digestibility. Six ileal-cannulated barrows (37.1 ± 0.8 kg BW) were fed 6 diets at 2.8 × maintenance for DE in six 9-d periods. Feces and ileal digesta were collected for 2 d each. The apparent total tract digestibility (ATTD) of energy was 1%-units higher (P = 0.009) for the diet containing ground rather than unground DDGS. Grinding of DDGS increased

(P < 0.01) the apparent ileal digestibility (AID) of Lys, Thr, and Met by 8.4, 1.5, and 2.6%-unit, respectively; it also increased (P < 0.05) the standardized ileal digestible (SID) of Lys and Met by 7.4 and 1.5%-unit, but not the ATTD of P. In diets containing ground DDGS, phytase and xylanase did not affect the ATTD of energy; phytase increased the ATTD of P but did not affect the AID or SID of AA. In contrast, xylanase did not increase these variables. In conclusion, particle size is an important physical characteristic impacting digestibility of energy and AA, but not P in DDGS. Phytate in DDGS limits digestibility of P, but not energy and AA. The substrate for xylanase did not appear to hinder nutrient digestibility.

**Key Words:** DDGS, phytase, pig

**165 Effects of pelleting diets containing distillers dried grain with solubles on growth performance and nutrient digestibility in nursery pigs.** Z. P. Zhu\*<sup>1,2</sup>, R. B. Hinson<sup>1</sup>, L. Ma<sup>1</sup>, and G. L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>China Agricultural University, Beijing, P. R. China.

Two experiments with 1,371 nursery pigs were conducted to compare effects of pelleted and non-pelleted diets containing distillers dried grain with solubles (DDGS) on growth performance and nutrient digestibility. In Exp. 1, 665 pigs (TR-4 × C22, 11.77 kg) were randomly allotted by sex and weight to diets containing 30% DDGS, but in different forms: meal or pellet, with 19 replicate pens/treatment and 17 to 19 pigs/pen. Growth performance was evaluated for three weeks. During the last week of the trial, 0.40% chromic oxide was added to the diets to allow for fecal collections to measure nutrient and energy apparent total tract digestibility (ATTD), with 10 pens/trt. In Exp. 2, 706 pigs (TR-4 × C22, 18.24 kg) were randomly allotted by sex and weight to the same diets as Exp. 1, with 21 replicate pens/treatment and 16 to 19 pigs/pen. Growth performance was evaluated for two weeks. In Exp. 1, pelleting improved (P<0.01) ADG (580 vs 540 g/d) and F:G (1.40 vs 1.49). No difference (P>0.05) in ADFI was observed. The ATTD (%) of DM (83.0 vs. 80.3), organic matter (84.8 vs. 82.3), energy (83.1 vs. 79.4), CP (78.8 vs. 76.2), fat (88.7 vs. 81.8), NDF (63.5 vs. 59.2) and ADF (65.7 vs. 61.3) for pelleted and non-pelleted diets, respectively, were improved by pelleting (P<0.05). The corresponding DE was 3,556 and 3,432 kcal/kg for pelleted and non-pelleted diets, respectively. In Exp. 2, ADG (720 vs 670 g/d) and F:G (1.47 vs 1.54) were improved by pelleting (P<0.01). No difference (P>0.05) in ADFI was observed. In conclusion, ADG and F:G were improved by pelleting the diet containing 30% DDGS. Additionally, nutrient and energy digestibility of the diet containing 30% DDGS was improved by pelleting.

**Key Words:** nursery pigs, pelleting, distillers dried grain with solubles

**166 Effect of single- or twin-screw extrusion on energy and amino acid digestibility of wheat or corn distillers dried grain and solubles (DDGS) for growing pigs.** E. Beltranena\*<sup>1,2</sup>, J. Sánchez Torres<sup>3</sup>, L. Goonewardene<sup>1,2</sup>, X. Meng<sup>1</sup>, and R. T. Zijlstra<sup>2</sup>, <sup>1</sup>Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada, <sup>2</sup>University of Alberta, Edmonton, Alberta, Canada, <sup>3</sup>Universidad Autónoma de Baja California, Mexicali, Baja California, México.

Extrusion may enhance nutrient digestibility of DDGS. Nine ileal-cannulated pigs (27.6 kg) were used to characterize the effect of extrusion on energy and AA digestibility of wheat and corn DDGS, and to compare single- vs. twin-screw extrusion. Wheat and corn DDGS were extruded using a single-screw InstaPro 2500 or a twin-screw Werner

& Pfeleiderer ZSK-57. In a 7 × 9 Youden square design, 7 diets (wheat DDGS, single-screw extrudate, twin-screw extrudate, corn DDGS, single-screw extrudate, twin-screw extrudate, N-free) were fed to 9 pigs at 2.8 × maintenance over 7 periods consisting of a 5-d diet adaptation, a 2-d collection of feces, and a 2-d collection of ileal digesta. Single- and twin-screw extrusion increased ( $P < 0.05$ ) the apparent total tract digestibility (ATTD) of energy by 5.0 and 4.5%, and the DE value of DDGS by 6.1 and 5.9%, respectively. Grain DDGS and extrusion interacted ( $P < 0.05$ ) for standardized ileal digestibility (SID) of 8 out of 10 indispensable AA. Extrusion increased ( $P < 0.05$ ) the SID of Lys by 11%, Trp by 8 % and Met by 5% for corn DDGS, but neither single- nor twin-screw extrusion affected SID of AA for wheat DDGS. Thus, single- and twin-screw extrusion are effective processing methods to increase energy digestibility of corn and wheat DDGS, but increased AA digestibility solely for corn DDGS.

**Table 1. Effect of single- or twin-screw extrusion on energy and amino acid digestibility of wheat or corn DDGS**

	Wheat DDGS			Corn DDGS			P value		
	Non	Single	Twin	Non	Single	Twin	DDGS	Extr	x Extr
ATTD GE, %	72.0	73.7	74.3	67.4	72.7	71.4	0.01	0.02	0.40
DE, Mcal	3.69	3.84	3.92	3.53	3.82	3.73	0.04	0.01	0.40
SID Lys, %	50.7	49.2	51.4	53.6	60.3	58.8	0.01	0.08	0.02
SID Thr, %	61.4	61.1	62.9	61.5	66.6	65.1	0.01	0.07	0.08
SID Met, %	80.7	80.7	82.8	80.8	86.2	85.2	0.01	0.01	0.01
SID Trp, %	80.3	78.1	80.2	72.9	78.5	78.6	0.01	0.03	0.01

**Key Words:** DDGS, extrusion, pigs

**167 Biofuel co-products in swine diets: Combining DDGS and glycerol.** P. J. Lammers<sup>\*1</sup>, M. S. Honeyman<sup>1</sup>, and B. J. Kerr<sup>2</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>USDA-ARS NSRIC, Ames, IA.

Biofuel production has rapidly increased in the United States resulting in higher market prices for corn and other feedstuffs and increased feed costs for pork producers. Biofuel production generates two major co-products—distillers dried grains with solubles (DDGS) from ethanol and crude glycerol from biodiesel. The objective of this study was to evaluate feeding crude glycerol and DDGS in combination to growing pigs. Pigs (n = 144) with an initial body weight of 39.4 kg were assigned to pens of 4 (2 barrows and 2 gilts per pen). Pens were randomly assigned to 1 of 6 dietary treatments. Dietary treatments were corn-soybean meal diets combined with crude glycerol and DDGS in a 2 × 3 factorial design (crude glycerol 0,10%; DDGS 0, 15, 25%). Diets were fed in three phases with diets in each phase formulated to be equal in ME and SID Lys. Pigs were fed for 84 days, scanned using real-time ultrasound, and harvested at an average weight of 124.7 ± 1.4 kg. At the processing plant, a sample of adipose tissue was collected from the jowl of each pig. Adipose tissue was analyzed for fatty acid composition. Analysis of variance for the 6 dietary treatments was performed with pen of pigs as the experimental unit. Pig performance and carcass traits did not differ between diets ( $P \geq 0.05$ ). Fatty acid profile was affected by dietary treatment ( $P < 0.01$ ). In pigs fed 0% glycerol, increasing DDGS from 15 to 25% resulted in less saturated fat ( $P < 0.01$ ). Including DDGS at any level or combination resulted in less saturated fat as compared to the control diet or the diet with 10% glycerol and 0% DDGS ( $P < 0.01$ ). Diets combining 10% glycerol and 15 or 25% DDGS were not different from each other for saturated fatty acid content ( $P < 0.01$ ), but had less polyunsaturated fatty acids than diets without glycerol ( $P < 0.001$ ). Feeding a combination of 10% glycerol and 25% DDGS can reduce the corn needed to feed a market pig by 40% with no change in growth

performance or calculated carcass traits. Adding glycerol may partially offset the effects of DDGS on the fatty acid profile of pigs.

**Key Words:** DDGS, glycerol, growing pigs

**168 Evaluation of crude glycerol, a biodiesel co-product, in growing pig diets to support growth and improve pork quality.** S. J. Schieck<sup>\*1</sup>, L. J. Johnston<sup>2</sup>, G. C. Shurson<sup>1</sup>, and B. J. Kerr<sup>3</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>West Central Research and Outreach Center, Morris, MN, <sup>3</sup>USDA-ARS, Ames, IA.

Two-hundred sixteen crossbred pigs (BW = 31.28 ± 1.76 kg) were used to determine the effects of long-term and short-term feeding of glycerol on growth performance, carcass traits, and pork quality of growing-finishing pigs. Pigs were blocked by initial BW, and pens within blocks were assigned randomly to 1 of 3 dietary treatments in a 4-phase feeding program (24 pens, 9 pigs/pen). Dietary treatments were: Control – a corn-soybean meal based diet (CON); Long-term – CON + 8% glycerol fed throughout the entire experiment (LT); and Short-term – pigs fed CON for the first 6 weeks followed by CON + 8% glycerol fed during the last 8 weeks of the experiment (ST). Pigs fed LT had higher ( $P < 0.05$ ) ADG and pigs fed ST tended ( $P = 0.07$ ) to grow faster than CON. Pigs assigned to LT but not ST expressed greater ( $P < 0.05$ ) ADFI compared to CON. Dressing percentage for pigs on LT and ST treatments was not different from CON-fed pigs. Fat-free lean percentage tended ( $P < 0.10$ ) to be greater in CON pigs than LT pigs. Short-term glycerol feeding increased ( $P < 0.05$ ) belly firmness compared to CON, and tended ( $P < 0.10$ ) to have firmer bellies than LT-fed pigs. Dietary treatments had no effect on total moisture loss or subjective color, marbling, and firmness scores of loins. Growing-finishing pigs fed diets containing 8% crude glycerol achieved growth performance similar to pigs fed a typical corn-soybean meal diet. Effects of crude glycerol on carcass traits appear to be limited to improvements in belly firmness with shorter-term feeding regimens.

**Table 1. Dietary effect of crude glycerol on overall performance, carcass traits and pork quality.**

Trait	CON	LT	ST	PSE
Initial wt, kg	31.47	31.33	31.03	0.15
Final wt, kg	126.7	128.9	128.9	0.78
ADG, kg	0.96 <sup>b</sup>	1.00 <sup>a</sup>	0.99 <sup>ab</sup>	0.01
ADFI, kg	2.78 <sup>a</sup>	2.93 <sup>b</sup>	2.86 <sup>ab</sup>	0.03
Dressing percent, %	74.5 <sup>ab</sup>	74.9 <sup>a</sup>	74.3 <sup>b</sup>	0.15
Fat-free lean, %	53.3 <sup>x</sup>	52.2 <sup>y</sup>	52.6 <sup>xy</sup>	0.34
Belly firmness, degrees	30.27 <sup>a</sup>	35.30 <sup>ab</sup>	42.26 <sup>b</sup>	2.27
Loin drip loss, %	3.18	3.22	3.60	0.46
Loin color score	3.84	3.80	3.77	0.12
Loin marbling score	2.47	2.57	2.51	0.20
Loin firmness score	2.31	2.66	2.26	0.17

<sup>ab</sup>Means with unlike superscripts differ ( $P < 0.05$ ). <sup>xy</sup>Means with unlike superscripts tend to differ ( $P < 0.10$ ).

**Key Words:** glycerol, pigs, pork quality

**169 Evaluation of crude glycerol to replace lactose in phase 1 nursery diets for pigs.** M. Shields<sup>\*</sup>, E. van Heugten, J. Odle, and C. Stark, North Carolina State University, Raleigh.

This study evaluated performance of nursery pigs fed glycerol for the first 14 days after weaning. The crude glycerol in this study contained 86.95% glycerol, 9.22% moisture, 1.26% sodium, 1.86% chloride, and 280 ppm methanol. Pigs (n=144; BW= 6.68 ± 0.17 kg) were weaned

at 21 days of age and housed 3 pigs per pen using 48 pens. Pigs were assigned to 6 dietary treatments (8 replicates), consisting of 0, 2.5, 5, 7.5, and 10% glycerol added to replace up to 10% lactose in a basal starter 1 diet containing 20% total lactose, and a negative control with 10% lactose and 0% glycerol. Diets were corrected for the added moisture and salt from the crude glycerol. Starter 1 diets were fed for 2 wk followed by a common starter 2 diet for 2 wk. Diets were pelleted and pellet mill electrical usage decreased up to 53% with increasing levels of glycerol. Glycerol in starter 1 diets linearly increased ( $P < 0.05$ ) pig BW on wk 2 and 3 of the study. ADG and ADFI increased linearly during wk 2 ( $P < 0.02$  and  $P < 0.05$ ) and the starter 1 period (0.20, 0.20, 0.25, 0.22, 0.27 kg/d for ADG;  $P < 0.01$  and 0.27, 0.27, 0.32, 0.32, 0.31 kg/d for ADFI;  $P < 0.04$ ) with increasing levels of glycerol. Gain/feed was not impacted by glycerol. Supplementation of 20% lactose compared to 10% lactose in the starter 1 diet had no effect on ADG, ADFI, and gain/feed, suggesting effects were due to glycerol and not lactose. Glycerol supplementation (10%) to diets that contained 10% lactose resulted in heavier pig BW at week 2 ( $P = 0.01$ ), greater ADG ( $P < 0.03$ ) during week 1, 2, and the starter 1 period (0.27 vs. 0.19 kg/d), and improved gain/feed ( $P < 0.04$ ) during week 1, 2, and the starter 1 period (0.87 vs. 0.68 kg/d) when compared to the negative control. Serum glycerol increased linearly in the starter 1 phase ( $P < 0.001$ ) with increasing levels of glycerol (7.1, 7.5, 31.1, 128.2, 96.9 mg/ml for 0, 2.5, 5, 7.5, and 10% glycerol, respectively). Growth performance was not affected when a common starter 2 diet was fed, or overall. Results indicate that supplementation of glycerol up to 10% improves ADG and ADFI in phase 1 diets and that this effect is independent of lactose.

**Key Words:** glycerol, lactose, performance

#### **170 Genetic and molecular mechanisms affecting phosphorus utilization.** C. H. Stahl\*, *North Carolina State University, Raleigh.*

Concerns over the environmental impact of excess Phosphorus (P) in the excreta of pigs and the dramatically rising cost of dietary inorganic P supplements have stressed the importance of minimizing the amount of P included in swine diets. Although there has been great interest in determining the lower threshold for dietary P levels, little work has examined the underlying regulatory mechanisms behind dietary P utilization in pigs. We have examined the impact of dietary P restriction on gene expression in order to help elucidate these mechanisms and from these studies have determined that there is a genetic effect on P utilization. Furthermore, we have identified a single nucleotide polymorphism in the calcitonin receptor gene that is associated with the response to subtle dietary P deficiency in growing pigs. In order to make further strides in maximizing the efficiency of P utilization, we have also begun to examine the relative importance of dietary P level during different developmental periods. Since classical P deficiency reduces both muscle and bone growth, we have begun to examine the effect of dietary P deficiency on the activity of the stem cells responsible for the post-natal growth of these tissues. In our studies, dietary P deficiency dramatically reduces the proliferation of both satellite cells which are responsible for muscle growth and mesenchymal stem cells which are responsible for bone growth and development in young pigs. Cell culture studies have further verified the potential for dietary P deficiency to have a profound impact on the activity of both satellite cells and mesenchymal stem cells isolated from young pigs. In these studies, the endocrine environment of P deficient pigs both prevents satellite cells from progressing through their myogenic lineage as well as favoring adipocytic rather than osteoblastic differentiation of mesenchymal stem cells. By establishing the impact of dietary P deficiency on these stem

cells, we will be able to develop more appropriate life stage feeding programs to maximize the efficiency of P utilization and growth as well as elucidate the mechanism by which genetics affect P utilization.

**Key Words:** phosphorus, swine, stem cells

#### **171 Presence of pharmacological quantities of Zn as a dose does not stimulate growth.** G. M. Hill\*, J. E. Link, J. A. Snedegar, and M. J. Dawes, *Michigan State University, East Lansing.*

Our laboratory (Carlson et al., 1999) was the first to report that feeding 3,000 ppm Zn as Zn oxide resulted in increased metallothionein (Mt) in the mucosa of the intestine, liver and kidney as well as an increase in villus height and crypt depth. However, the exact mechanism for the stimulation of growth in the nursery pig by pharmacological Zn has not been determined. The goal of this research was to determine if a pharmacological dose of Zn at weaning would result in similar growth as feeding 2,000 ppm Zn for the first 2 wk in the nursery. In study 1, 5 pigs were killed at weaning for baseline tissue concentrations and 20 pigs were drenched with 2800 mg Zn from MAAC (Zn amino acid chelate, Albion) or with the same amount of liquid without Zn. Half of the drenched pigs were killed at 24 or 48 h post-drench. Hepatic Zn (239 vs. 91, 83  $\mu\text{g/g}$ , respectively) and mucosal and hepatic Mt concentrations were higher ( $P < 0.0001$ ) for pigs drenched with 2800 mg Zn at 24 and 48 h than in baseline pigs or those without the Zn drench. Hepatic Zn concentrations at 48 h were significantly greater than those at 24 h (239 vs. 333  $\mu\text{g/g}$ , respectively). In study 2, 24 and 48 pigs were fed 2,000 or 150 ppm Zn as Zn oxide, respectively. Half the pigs fed 150 ppm Zn were drenched with 1535 mg Zn in a slurry similar to study 1. After 2 wk, the ADG was greater for pigs fed 2,000 ppm Zn (0.27 kg) or 150 ppm Zn (0.23 kg) than those fed 150 ppm Zn plus 1535 mg Zn drench (0.15 kg;  $P = 0.001$ ). After 2 wk, G:F was greater ( $P = 0.008$ ) for these same 2 treatments. Utilizing the same treatments in study 3 ( $n = 32/\text{treatment}$ ) except one half of the pigs fed 2,000 ppm Zn were switched to 150 ppm during wk 3. Overall ADG did not differ for pigs on any treatment. In summary, 2,000 ppm dietary Zn from Zn oxide stimulates growth during the first 2 wk following weaning, but a pharmacological Zn dose does not. The presence of Mt holding Zn in the mucosa for rapidly growing cells does not result in improved growth.

**Key Words:** nursery pig, pharmacological Zn, metallothionein

#### **172 The effects of KemTRACE® brand Chromium Propionate on growth performance of grow-finish pigs fed reduced fat diets.** B. Hinson\*<sup>1</sup>, J. Hahn<sup>2</sup>, and G. Allee<sup>1</sup>, <sup>1</sup>*University of Missouri, Columbia,* <sup>2</sup>*Kemin Industries, Inc., Des Moines, IA.*

This trial evaluated the effect of chromium (Cr), provided as chromium propionate (CrP), on performance of pigs fed diets with fixed levels of standard ileal digestible lysine (SIDLYS) and decreasing fat levels. A 2x3 factorial design utilized  $\pm 200$  ppb Cr and fat addition (3, 2, 1% added) as factors. Reducing fat created increased SIDLYS to ME (SIDLYS:ME) ratios. Eight hundred and ten crossbred pigs (396 barrows, 414 gilts) with an initial wt. of 36.4 kg were randomly assigned to pens. Pens were weighed and 3 replicate pens of barrows and 3 replicate pens of gilts (22 and 23 pigs/pen for barrows and gilts, respectively) were allotted to each of six treatment regimens. In the last phase prior to marketing, Paylean® was added to all diets. Barrows responded to CrP supplementation with increased ( $P < 0.05$ ) ADG for day 0-63 period of the trial (863 and 835 g/d for CrP and control respectively). The increase was greatest for pigs fed the highest SIDLYS:ME ratio diet. Gilts did not respond ( $P > 0.10$ ) to CrP supplementation prior to the Paylean feeding period. During the

Paylean period, gilts receiving CrP and Paylean had increased ( $P < 0.10$ ) ADG relative to gilts receiving only Paylean (1126 and 1056 g/d for CrP + Paylean and Paylean, respectively). For the total trial period, no significant response ( $P > 0.10$ ) occurred for the main effect of Cr addition or fat level. A significant ( $P < 0.05$ ) interaction occurred between Cr and fat level in the day 0-63 period. The interaction resulted from a gain:feed improvement observed for pigs fed the diets with high SIDLYS:ME (lowest energy) in combination with 200 ppb Cr which did not occur when pigs were fed these diets without Cr supplementation. Response to CrP was maximized in early periods for barrows. Gilts had a limited potential to respond to CrP in finishing, responding only when Paylean was utilized. CrP effect on gain:feed in high SIDLYS:ME, lower energy diets suggest a need for further evaluation of this interaction.

**Key Words:** pigs, chromium propionate, supplemental fat

**173 Effects of dietary concentration of P and microbial phytase on the digestibility of amino acids and energy by growing pigs.** A. A. Pahl<sup>1</sup>, G. I. Petersen<sup>\*1</sup>, N. R. Augspurger<sup>2</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>JBS United Inc., Sheridan, IN.

Previous research has shown that the standardized ileal digestibility (SID) of AA and the apparent ileal (AID) or the apparent total tract digestibility (ATTD) of energy may be improved if exogenous microbial phytase is added to diets fed to pigs, but that is not always the case. The objective of this experiment was, therefore, to test the hypothesis that the concentration of dietary P affects the influence of microbial phytase on AA and energy digestibility in corn-soybean meal diets fed to growing pigs. Fourteen barrows (initial average BW: 35.0 kg) that were prepared with a T-cannula in the distal ileum and housed in individual pens were randomly allotted to a replicated  $7 \times 7$  Latin square design with 7 diets and 7 periods. Six of the diets were used in a  $2 \times 3$  factorial design with 2 levels of calculated digestible P (0.13 and 0.23%) and 3 levels of exogenous microbial phytase (0, 250, or 500 units per kg). An N-free diet that was used to measure ileal endogenous AA losses was formulated as well. The microbial phytase that was used was Optiphos (Enzyvia LLC, Sheridan, IN). Data were analyzed as a  $2 \times 3$  factorial using PROC MIXED of SAS. In diets containing 0.13% digestible P, phytase improved (linear,  $P \leq 0.05$ ) the SID of indispensable AA (83.3, 87.2, and 88.8%), the AID of energy (71.62, 75.03, and 78.41%), and the ATTD of energy (84.2, 85.0, and 87.7%) for diets containing 0, 250, and 500 units of phytase, respectively. Increasing the concentration of digestible P in the diets from 0.13 to 0.23% increased ( $P \leq 0.05$ ) the SID of AA from 86.6 to 88.8%, and the AID of energy from 75 to 79.4%, indicating that dietary P by itself has a significant impact on the digestibility of AA and energy. However, adding phytase to the diet containing 0.23% digestible P had no effect on the digestibility of AA or energy resulting in an interaction ( $P \leq 0.05$ ) between dietary P and phytase. These observations indicate that the observed improvement in AA and energy digestibility with phytase supplementation to P-deficient diets may be a result of greater P absorption rather than solely enzymatic activity.

**Key Words:** AA digestibility, energy digestibility, phytase

**174 Addition of ZINPRO<sup>®</sup> zinc methionine complex to late finishing swine diets containing ractopamine enhances growth rate.** J. W. Frank<sup>\*1</sup>, C. V. Maxwell<sup>1</sup>, Z. B. Johnson<sup>1</sup>, T. L. Ward<sup>2</sup>, and M. E. Wilson<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Zinpro Corporation, Eden Prairie, MN.

In order to evaluate the effect of feeding zinc methionine complex in combination with ractopamine, 180 pigs (GPK35  $\times$  EBU, initial BW

= 34.3 kg) were used in a grow-finish study. Pigs were housed 5 pigs/pen and fed a control diet (CON) with typical mineral premix inclusion rates (provided 165 and 138ppm Zn from ZnSO<sub>4</sub> in Phase 1-3 and Phase 4-5, respectively) or the control diet plus ZINPRO zinc methionine (Zn) in place of corn (454 g/ton; provided an additional 50 ppm Zn and 0.01% Methionine). At the beginning of Phase 5 (BW = 109.2 kg), pigs were allotted within mineral treatment to diets containing ractopamine (RAC) at 4.5 g/ton (0.89% TID Lys and 0.52% TID Met + Cys) or no RAC (0.58% TID Lys and 0.39% TID Met + Cys), resulting in a  $2 \times 2$  factorial arrangement of treatments. There was no effect of Zn supplementation on ADG, ADFI, or G:F during Phases 1 through 4 ( $P > 0.19$ ). During Phase 5, pigs fed RAC had improved ADG ( $P = 0.001$ ) and G:F ( $P = 0.001$ ). At market, pigs fed RAC had increased final BW ( $P = 0.03$ ) and hot carcass weight ( $P = 0.08$ ). Interestingly, there was a Zn  $\times$  RAC interaction for Phase 5 ADG and ADFI. Pigs fed Zn + RAC had greater ADG compared to Zn alone (1.279 vs. 1.028 kg), while there were no differences between CON + RAC and CON pigs (1.155 vs. 1.130 kg; Zn  $\times$  RAC,  $P = 0.005$ ). ADFI for CON, CON + RAC, Zn, and Zn + RAC during Phase 5 were 3.394, 3.153, 3.213, and 3.436 kg, respectively (Zn  $\times$  RAC,  $P = 0.01$ ). There were no differences in percent lean or carcass yield ( $P > 0.23$ ). Final BW for CON, CON + RAC, Zn, and Zn + RAC were 131.5, 132.8, 129.7, and 134.8 kg, respectively (RAC,  $P = 0.03$ ). In conclusion, RAC improves growth rate and feed conversion in finishing pigs. In addition, the effects of feeding RAC on growth were enhanced in pigs fed ZINPRO zinc methionine complex, resulting in heavier pigs at market.

**Key Words:** pigs, zinc, ractopamine

**175 Reducing the Ca:P ratio in phytase-supplemented diets did not compromise growth or feed intake responses of nursery pigs.** C. Sparks<sup>\*1</sup>, J. Lampe<sup>2</sup>, G. Gourley<sup>2</sup>, and T. Crenshaw<sup>3</sup>, <sup>1</sup>Lallemand Animal Nutrition, Alden, IA, <sup>2</sup>Swine Graphics Enterprises, Webster City, IA, <sup>3</sup>University of Wisconsin, Madison.

Increased feed costs and volatile ingredient prices have pressured nutritionists to re-evaluate nutrient relationships to maintain economic efficiency. Inclusion of phytase supplements in swine diets offer economically effective alternatives to inorganic phosphate. However, questions arise about adjustments to the Ca:P ratio in phytase-supplemented diets. The efficacy of phytase may be compromised if excess Ca is added to maintain a traditional Ca:P ratio. A 27 d trial (616 nursery pigs, 11 pigs/pen, 14 pens/treatment) compared responses of nursery pigs ( $8.9 \pm 0.13$  kg) fed phytase-supplemented diets with a Ca:P ratio of either 0.80, 0.95, or 1.10. Phytase (750 FTU/kg from Phyzyme XP equivalent to 0.15% aP) was added to basal diets formulated with 0.20% aP to provide 0.35% aP. A control (Ctl, no phytase) diet was formulated to provide 0.35% aP and a Ca:P ratio of 1.10 using dicalcium phosphate and limestone. Silica sand was used to maintain isocaloric concentrations among all diets. By analysis, diets with added phytase contained 830, 870 and 740 FTU/kg. Analysis of Ca and total P in Ctl (0.70, 0.63%) and phytase diets (0.43, 0.50; 0.50, 0.49; and 0.56, 0.50% Ca, P respectively) provided Ca:P ratios of 1.11 (Ctl), 0.86, 1.02, and 1.12. Growth and feed intake of pigs fed Ctl diets was lower ( $P < 0.05$ ) than that of pigs fed diets with phytase. No differences were detected among pigs fed diets with phytase regardless of Ca:P ratio. Thus in diets supplemented with 750 FTU/kg, lower Ca:P ratios did not compromise growth, indicating that lower Ca:P ratios may not improve efficacy of phytase use. However, based on commercial diet costs at the time of this trial, lower total feed costs occurred with pigs fed phytase-supplemented diets with lower Ca:P ratios (0.80 or 0.95) than pigs fed Ctl diets or phytase-supplemented diets with a Ca:P ratio of 1.10.

**Table 1. Dietary Treatments**

	SEM				
Ca:P ratio	1.10	0.80	0.95	1.10	
Phytase, FTU/kg	0	750	750	750	
ADG, kg/d <sup>a</sup>	0.496	0.510	0.515	0.517	0.006
FI, kg/d <sup>a</sup>	0.702	0.721	0.722	0.723	0.014
Feed:Gain ratio	1.419	1.416	1.402	1.402	0.009

<sup>a</sup>Ctl vs phytase-supplemented diets differ, P<0.05

**Key Words:** Ca:P ratio, phytase, feed costs

**176 Effect of extracted corn meal from a fractionation process on pig growth performance and carcass characteristics.** B. Isaacson\*, T. J. Baas, C. R. Schwab, and K. Schulte, *Iowa State University, Ames.*

The objective of this study was to determine the effect of extracted corn germ (ECG) from a fractionation process on growth performance and carcass characteristics of grow-finish pigs. Pigs were phase-fed six diets (lysine levels of 1.14%, 1.02%, 0.93%, 0.84%, 0.74%, and 0.61%, respectively) from 23 kg to 127 kg. The control diet (C) was a corn, soybean meal, and premix diet, with corn in the treatment diet replaced with ECG. Control and treatment diets were formulated to equal levels of lysine and energy in each phase. A total of 2,400 crossbred (PIC 337 x Genetiporc) pigs were split equally between treatments in a commercial wean-to-finish facility and evaluated from 5.5 kg to 127 kg. At time of entry, 183 pigs assigned to the C diet and 159 pigs assigned to the ECG diet were randomly selected for performance and carcass evaluation. Pigs were weighed on test and started on dietary treatments at 23 kg BW. Average daily gain was greater for the C-fed pigs from 23 to 85 kg (900 g vs. 836 g), 85 kg to 127 kg (914 g vs 831 g), and 23 kg to 127 kg (P < 0.001, 914 g vs. 841 g). Treatment effects were not different for LMA and percent lean, and there was a trend for ECG-fed pigs to have less 10th-rib backfat (P = 0.08). Pigs fed the C diet had lower Minolta (P < 0.01) and Hunter L\* values (P < 0.001) at both 24 and 48 h post-mortem. At 24 h post-mortem, pH was not affected by treatment, but there was a trend for the C-fed pigs to have a higher pH at 48 h (P = 0.06). Pigs from the C diet had a greater subjective color score (P < 0.05), but marbling and firmness were not different. Forty-eight hour b\* values evaluated on subcutaneous fat indicated a trend (P = 0.06) for the ECG-fed pigs to have a whiter fat. Fat samples from 24 pigs on each treatment were evaluated to determine iodine value; pigs fed the ECG diet had a lower iodine value (P < 0.01, 70.72 vs. 72.9) than pigs fed the C diet, indicating a more saturated fat. Further research is needed to determine the optimum inclusion level of ECG in grow-finish swine diets.

**Key Words:** corn germ, fractionation, pig

**177 Nutritional value of flaxseed meal for swine.** L. Eastwood and P. Leterme\*, *Prairie Swine Centre Inc., Saskatoon, SK, Canada.*

Flaxseed meal (FSM), a by-product of the flax crushing industry, contains an average of 34% crude protein (CP) and 13% fat on a DM basis. The CP fraction is characterized by a low lysine content (4.1% of CP) but is high in tryptophan (1.2%), methionine (1.9%) and threonine (3.7%). Two experiments were conducted to determine the nutritional profile of FSM for pigs. In Exp. 1, apparent nutrient digestibilities (AD) and the DE and NE content of FSM was determined using 24 gestating sows (P2-P4) and 32 barrows (70 kg). The NE content was estimated with a prediction equation based on the DE content of FSM and its chemical composition. Pigs were fed one of 4 diets containing 0, 10, 20 or 30% FSM at the expense of barley, wheat and soybean meal in a completely

randomized design. Celite was included as a source of acid insoluble ash (AIA). Fecal grab samples were collected for 3 d following a 9 d acclimation period and were analyzed for DM, gross energy (GE), fat, ash and AIA. Calculated by regression, the AD coefficients for DM, ash, and GE were 72, 28 and 71% respectively for growing pigs and those of DM, ash, fat and GE were 68, 22, 49 and 73% for sows. The DE and NE contents were 3.52 and 2.46 Mcal/kg DM for growing pigs and 3.58 and 2.49 Mcal/kg DM for sows. In Exp. 2, 5 barrows (38 kg) were fitted with T-cannulas at their terminal ileum to determine the standardized ileal AA digestibility (SID) of FSM. Pigs were fed a semi-synthetic diet containing 40% FSM as the only source of N for 7 d (4 d acclimation, 3 d digesta collection) followed by a similar 7 d period in which an N-free synthetic diet was fed. Both the diets and digesta samples were analyzed for their amino acid (AA) content and chromic oxide levels. The SID AA content (g/kg dry FSM) was 29.6, 5.7, 12.1, 16.8, 10.3, 5.3, 14.0, 9.4, 2.9, 13.8 and 12.2 for Arg, His, Ile, Leu, Lys, Met, Phe, Thr, Trp and Val respectively. In conclusion, FSM contains a similar nutritional value to that of canola meal for pigs but offers a higher DE and NE content, thanks to its high fat content. The main limiting factor could be its low lysine content.

**Key Words:** flaxseed meal, pig, nutritional value

**178 Varietal effects of barley carbohydrate composition on digestibility, fermentability and microbial ecophysiology in an in vitro model of the pig gastrointestinal tract.** J. Bindelle<sup>1,2</sup>, R. Pieper<sup>3,4</sup>, B. Rossnagel<sup>4</sup>, A. Van Kessel<sup>\*4</sup>, and P. Leterme<sup>3,4</sup>, <sup>1</sup>*Fonds national de la Recherche scientifique, Belgium*, <sup>2</sup>*Gembloux Agricultural University, Belgium*, <sup>3</sup>*Prairie Swine Centre Inc., Canada*, <sup>4</sup>*University of Saskatchewan, Canada.*

Carbohydrate (CHO) composition can vary markedly between barley varieties. Their influence on digestibility, intestinal fermentation and microbiota in pigs was studied in vitro. Ten hullless (HLB) and 6 hulled barleys (HB) differing in B-glucan, non-starch polysaccharides (NSP), starch content, and amylose/amylopectin ratio, were hydrolyzed enzymatically and subsequently fermented for 72h. CHO fermentation kinetics were modeled; microbial composition and short-chain fatty acid (SCFA) production were analyzed.

In HLB, in vitro DM digestibility was positively correlated to starch and amylopectin content and CP digestibility to amylopectin (P<0.05), whereas both were negatively correlated to insoluble NSP (P<0.05). Rate of fermentation was different (P<0.01) between barley types but not correlated to the CHO composition. However, high B-glucan contents induced faster fermentation (P<0.05, HLB; P<0.10, HB). SCFA molar ratios after fermentation of HLB were higher in propionate and branched-chain fatty acids and lower in acetate compared to HB (P<0.01). With HLB, amylose content was positively correlated to butyrate production and negatively to propionate, which was positively correlated to soluble NSP content (P<0.01). In HB, no correlation between SCFA production and the carbohydrate composition was found. TRFLP analysis revealed that Bacteroides and members of Clostridium cluster XIVa were differentially affected in HLB compared to HB as well as by the type and source of CHO. Microbial profiles were also correlated (P<0.05) to SCFA and fermentation parameters but response differed significantly between HB and HLB. The strongest correlation between CHO structure, microbial abundance and fermentation parameters was evident in HLB. Hullless barleys may offer the greatest opportunity to improve gut health in pigs.

**Key Words:** barley, fermentation, microbiota

**179 Digestible and net energy content of white and regular flakes of yellow and black canola meals of Brassica napus and B. juncea in growing pigs.** C. A. Montoya\*, K. Neufeld, P. Kish, and P. Leterme, *Prairie Swine Centre Inc., Saskatoon, SK, Canada.*

The digestible (DE) and net (NE) energy content of canola meal (CM) in monogastric animals is limited by its high dietary fibre content. A breeding program based on yellow cultivars of *Brassica napus* and *Brassica juncea* has been initiated to develop canola seeds with lower fibre content, especially that of lignin. Also, the defatted meal is normally toasted to destroy antinutritional factors and evaporate solvent residues but excessive toasting can negatively affect digestibility. Therefore, an experiment (factorial 3x2) was conducted in growing pigs to determine the DE content and estimate the NE content of 3 different CM: yellow *B. napus* (YBN); black *B. napus* (BBN) and yellow *B. juncea* (BJ) that were toasted (regular flakes) or not (white flakes). A basal diet and 6 CM-based diets (2/3 basal diet, 1/3 CM) were prepared. A total of 42 growing pigs (28 kg; 6/treatment) were kept in metabolic cages for 18 d and their feces totally collected for the last 10 d. The digestibilities (DM, N and energy), DE and NE content were tested for CM type and flake type. The NE content was estimated by means of a prediction equation based on the DE content and chemical composition of the CM. Dry matter and energy digestibilities were greater ( $P < 0.05$ ) for the YBN and BJ types compared to the BBN type. This could be ascribed to a lower NDF content (162 vs 217 g/kg, respectively) for the yellow-seeded canolas. A higher DE and NE content was observed for YBN and BJ as compared to BBN ( $P = 0.007$ ). There was no impact ( $P > 0.05$ ) of toasting, or any interaction between toasting and canola type on nutrient digestibility or DE or NE content. In conclusion, toasting had no negative effect on the fecal apparent digestibility and energy values in growing pigs whereas yellow-seeded canolas presented higher DE and NE content than the CM of black *B. napus* seeds.

**Key Words:** canola meal, pig, net energy

**180 Effects of Oxidized Corn Oil and Synthetic Antioxidant Blend on Animal Performance in Finishing Pigs.** D. M. Fernandez-Dueñas<sup>1</sup>, L. W. Kutzler<sup>1</sup>, D. D. Boler<sup>1</sup>, J. Zhao<sup>2</sup>, R. J. Harrell<sup>2</sup>, J. Andrews<sup>2</sup>, M. Vazquez-Añon<sup>2</sup>, M. Ellis<sup>1</sup>, J. Killefer<sup>1</sup>, and F. K. McKeith<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*Novus International Inc., St. Charles, MO.*

The objective of this experiment was to evaluate the effect of dietary oxidized oil and a blend of synthetic antioxidant (AOX, ethoxyquin and tertiary butyl hydroquinone; Novus International Inc.) on growth performance in finishing pigs. A total of 160 barrows (80.2±2.36 kg) were assigned to one of four dietary treatments with 8 pens per treatment and 5 pigs per pen. The trial was a 2x2 factorial design, with 2 types of corn oil (5% Fresh vs. Oxidized) with or without AOX. Pigs were on the experimental diets for 56 days, and 5 ppm Ractopamine was added during the last 28 days. Oxidized oil was produced by bubbling oxygen in a heated container up to 48 hrs to reach a target peroxide value (PV) of 150mEq/kg and 7.5mEq/kg for the final diet. Pigs fed oxidized oil were 3.9 kg lighter than those fed fresh oil on day 56 (136.0 vs. 139.9kg,  $P < 0.05$ ). Oxidized oil reduced ADFI in week 1 (9%) and 2 (7%), while AOX increased ADFI in week 3 (9%) and 4 (11%,  $P < 0.10$ ). Overall ADFI was reduced by 5% with oxidized oil with 2.85 and 3.00 kg for the oxidized and fresh oil, respectively ( $P < 0.05$ ). Cumulative ADG was reduced with oxidized oil on day 14, 49, and 56 ( $P < 0.05$ ). The most profound benefits of AOX was observed in week 3, when AOX improved ADG (0.77 vs. 0.97 kg,  $P < 0.01$ ), ADFI (2.63 vs. 2.86kg,  $P < 0.10$ ), and GF (0.291 vs. 0.342,  $P < 0.01$ ) compared to the control. Two-way interaction of oxidized oil and AOX was observed on cumulative

G:F on 21 ( $P < 0.10$ ). Barrows fed oxidized oil with AOX had greater G:F than those fed oxidized oil without AOX (0.325 vs. 0.292 on 21d), whereas animals fed diets containing fresh oil with or without AOX were not different (0.319 vs. 0.318 on 21d). In summary, oxidized oil impaired growth performance and AOX ameliorate the negative effect of oxidized oil in finishing pigs.

**Key Words:** oxidized oil, antioxidant, pig growth performance

**181 Amino acid digestibility and energy concentration in full fat soybeans from conventional, high protein, or low oligosaccharide varieties and in soybean meal fed to weanling pigs.** K. M. Baker\*, B. G. Kim, and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted using 3 sources of full fat soybeans (FFSB) and 1 source of soybean meal (SBM). The FFSB were produced from conventional (FFSB-CV), high-protein (FFSB-HP), and low oligosaccharide (FFSB-LO) varieties of soybeans that contained 37.6, 44.6, and 39.0% CP, respectively. The SBM was produced from a conventional variety of soybeans and contained 49.7% CP. The standardized ileal digestibility (SID) of AA in the 4 ingredients was measured using 10 barrows (10.1 ± 1.82 kg BW) that were equipped with a T-cannula in the distal ileum and allotted to a replicated 5 × 5 Latin square design with 5 periods and 5 diets per square. Three diets contained FFSB-CV, FFSB-HP, or FFSB-LO and 1 diet contained SBM as the sole source of AA. An N-free diet was used to determine basal ileal endogenous losses of AA. Each period lasted 7 d and ileal digesta were collected on d 6 and 7 of each period. The SID for Leu, Lys and Phe in FFSB-CV were greater ( $P \leq 0.05$ ) than in SBM, but no differences were observed in the SID of AA between FFSB-HP, FFSB-LO and SBM. The ME in the 3 sources of FFSB and SBM were measured using 40 barrows (18.5 ± 1.54 kg BW) that were placed in metabolism cages and randomly allotted to 5 diets. A corn-based diet and 4 diets containing corn and FFSB-CV, corn and FFSB-HP, corn and FFSB-LO, or corn and SBM were formulated. Urine and feces were collected over a 5-d period following a 7-d adaptation period. The ME in each source of FFSB and in SBM were calculated using the difference procedure. The concentration of ME in FFSB-CV, FFSB-HP, FFSB-LO, and in SBM was 4,990, 4,515, 4,769, and 3,970 kcal/kg DM, respectively. All these values were different ( $P \leq 0.05$ ). We conclude that FFSB-CV has a greater SID of Leu, Lys, and Phe and a greater concentration of ME than SBM if fed to weanling pigs. Likewise, the ME in FFSB-HP and FFSB-LO is greater than in SBM.

**Key Words:** amino acids, energy, full fat soybeans

**182 Effects of cracked corn on growth performance and stomach lesions in finishing pigs.** S. M. Williams\*, J. D. Hancock, S. Issa, and T. L. Gugle, *Kansas State University, Manhattan.*

A total of 208 pigs (104 barrows and 104 gilts with an average initial BW of 63 kg) were used in a 63-d growth assay to determine the effects of adding cracked corn to diets for finishing pigs. The pigs were sorted by ancestry and blocked by BW with 13 pigs per pen and four pens per treatment. Treatments were a corn-soybean meal-based control with none, 10, 20 or 40% roller-milled corn (mean particle size of 3,549 µm). Particle size for the none, 10, 20 and 40% cracked corn treatments were 684, 926, 979, and 1,187 microns, respectively. Feed and water were consumed ad libitum until the pigs were slaughtered (average final BW of 122 kg) at a commercial abattoir. Increasing the amount of cracked corn in the diet from none to 40% had no effect on ADG or ADFI ( $P > 0.4$ ), but G:F was decreased by 4% (linear effect,  $P$

< 0.1). As for carcass data, adding cracked corn had no effect on HCW ( $P > 0.17$ ) or backfat thickness ( $P > 0.69$ ), but dressing percentage was decreased (linear effect,  $P < 0.05$ ). Finally, there were linear decreases in scores for keratinization and ulcers (scale of 0 = none, 1 = mild, 2 = moderate, and 3 = severe) as cracked corn was increased from none to 40% ( $P < 0.01$ ), but even the worst treatment had an average lesion score of less than mild. For diets with none, 10, 20, and 40% cracked corn, ADG was 918, 952, 935, and 928 g/d, ADFI was 2.58, 2.72, 2.68, and 2.70 kg/d, G:F was 356, 350, 349, and 344 g/kg, HCW was 89.2, 90.6, 89.9, and 88.0 kg, backfat thickness was 26.7, 26.7, 26.9, and 26.7 mm, dressing percentage was 74.0, 73.7, 73.7, and 72.7%, keratinization score was 0.21, 0.18, 0.08, and 0.05, and ulcer score was 0.22, 0.04, 0.02, and 0, respectively. Our results indicate that increasing cracked corn from none to 40% of diets for finishing pigs did not affect rate of gain but decreased efficiency of growth and dressing percentage with only slight improvements in scores for stomach lesions.

**Key Words:** finishing pigs, cracked corn, ulcers

**183 The effects of feeder design on growth performance and carcass characteristics of finishing pigs.** J. R. Bergstrom\*, M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouche, and R. D. Goodband, *Kansas State University, Manhattan.*

Two experiments were conducted to compare the effects of feeder design (conventional dry feeder, Staco® vs. wet-dry feeder, Crystal Springs®) on finishing pig performance. In both experiments, water was provided in pens with a dry feeder via a bowl drinker; whereas, the wet-dry feeder provided the only source of water for those pens. In Exp. 1, 1,186 pigs (32.1 kg BW) were used in a 69-d experiment. There were 26 to 28 pigs/pen and 22 pens/feeder type in a CRD. All pigs were fed the same dietary sequence in 4 phases. Overall (d 0 to 69), pigs fed with a wet-dry feeder had greater ( $P < 0.001$ ) ADG (1.03 vs. 0.95 kg/d), ADFI (2.53 vs. 2.33 kg/d), and final BW (103.1 vs. 98.2 kg) than pigs fed with a dry feeder. In Exp. 2, 1,236 pigs (28.7 kg BW) were used in a 104-d experiment, with 25 to 28 pigs/pen and 23 pens/feeder type. From d 0 to 84, all pigs were fed the same diets in 4 phases according to a feed budget. On d 84, the 3 largest pigs in each pen were removed for marketing, and the remaining pigs were placed on diet containing 5 ppm Paylean® until the end of the experiment (d 104). Carcass measurements were obtained from pigs in 11 pens/feeder type on d 104. Overall (d 0 to 104), pigs fed with a wet-dry feeder had greater ( $P < 0.002$ ) ADG (0.91 vs. 0.86 kg/d), ADFI (2.45 vs. 2.25 kg/d), final BW (123.8 vs. 118.6 kg), feed cost/pig (\$61.12 vs. \$56.23), and backfat depth (18 vs. 16 mm) than pigs fed from a dry feeder. However, pigs fed with a wet-dry feeder also had reduced ( $P < 0.03$ ) G:F (0.37 vs. 0.38), carcass yield (75.2 vs 76.9%), FFLI (49.9 vs. 50.5), premium/pig (\$5.26 vs. \$8.67), and revenue/kg live BW (\$1.21 vs. \$1.24). Combined, these effects resulted in a similar ( $P = 0.36$ ) net income/pig (\$24.28 vs. \$26.15). In summary, growth performance was improved for pigs fed with a wet-dry feeder compared to a dry feeder. However, carcasses of pigs fed with a wet-dry feeder were fatter and yielded less than pigs fed with a dry feeder.

**Key Words:** growth, feeders, pigs

**184 Effects of feeder adjustment on growth performance of finishing pigs.** A. W. Duttlinger\*, S. S. Dritz, M. D. Tokach, J. M. DeRouche, J. L. Nelssen, and R. D. Goodband, *Kansas State University, Manhattan.*

Two studies were conducted to determine the effects of feeder adjustment on growth performance of finishing pigs. In Exp. 1, 1,170 barrows and

gilts (58.5 kg BW) were used in a 70-d study. Pigs were blocked by BW and allotted to 1 of 5 treatments with 9 pens per treatment. Treatments were feeder settings of 1, 2, 3, 4, or 5 for STACO® stainless steel 5-hole dry feeders with maximum height below the feed gate of 3.60, 3.28, 2.95, 2.65, and 2.20 cm, respectively. Overall, reducing feeder opening decreased (linear,  $P < 0.03$ ) ADFI (2.14, 2.15, 2.11, 2.06, and 2.07 kg/d; SE 0.07). Feeder setting did not affect ( $P > 0.18$ ) ADG (0.80, 0.82, 0.82, 0.80, and 0.80 kg/d; SE 0.02) or G:F (0.38, 0.38, 0.39, 0.39, and 0.39; SE 0.04). In Exp. 2, 1,250 barrows and gilts (35.1 kg BW) were used in a 69-d study to determine the effect of feeder setting and diet type. Pigs were blocked by BW and allotted to 1 of 6 treatments with 8 pens per treatment. Treatments were arranged in a 3 × 2 factorial with main effects of STACO® feeder setting (1, 3, or 5) and diet type (corn-soybean meal or byproduct-based with 15% DDGS and 5% bakery byproduct). Overall, there were no feeder setting × diet interactions ( $P > 0.31$ ). Diet type did not affect ( $P > 0.75$ ) pig performance. Widening feeder openings increased ADG (quadratic,  $P < 0.03$ ) and ADFI (linear,  $P < 0.01$ ). Feeder setting tended to influence (quadratic,  $P > 0.08$ ) G:F with the best G:F at feeder setting 3. In conclusion, with the dry feeders used in this study, feed should cover slightly more than half of the feed pan to not limit pig performance.

**Table 1. Trial 2. Main effects of feeder settings.**

Item	Feeder Setting:			
	1	3	5	SE
D 0 to 69				
ADG, kg	0.94	0.93	0.88	0.01
ADFI, kg	2.25	2.18	2.08	0.02
G:F	0.42	0.43	0.42	0.01
Maximum height below feed gate, cm	3.59	2.89	2.20	0.05
Week 2 feeder pan coverage, %	79.4	55.0	18.6	4.9
Week 6 feeder pan coverage, %	80.0	61.8	24.1	4.6

**Key Words:** feeder adjustment, DDGS, pig

**185 Effect of incremental levels of red blood cells on growth performance, linear carcass traits, and viscera and organ weights of finishing pigs.** E. D. Frugé\*, T. D. Bidner, and L. L. Southern, *LSU Agricultural Center, Baton Rouge, LA.*

Three experiments were conducted to determine the effect of graded levels of red blood cells (RBC; 0 to 4%, Exp 1; 0 to 2%, Exp 2 and 3) on growth performance and carcass traits of finishing pigs. Diets were formulated to contain 0.52 and 0.59% apparent ileal digestible Lys for barrows and gilts, respectively. Treatments in all Exp had 4 reps (Exp 1, 2 reps of barrows and 2 reps of gilts; Exp 2, 4 reps of barrows and 4 reps of gilts; Exp 3, 4 reps of barrows) with initial and final BW of 83.5 and 119.4 kg (Exp 1), 80.9 and 122.7 kg (Exp 2) and 86.0 and 133.4 kg (Exp 3). One to 3 pigs per pen were killed for measurement of carcass traits and viscera weights (viscera weights in Exp 2 and 3 only). In Exp 1, ADG (0.83, 0.81, 0.79, 0.82, and 0.68 kg/d; quadratic,  $P < 0.08$ ) and G:F (0.28, 0.29, 0.28, 0.27, and 0.25 g/kg; linear  $P < 0.10$ ) were decreased as RBC addition increased, but the effect was more pronounced at the 4% addition. The RBC addition increased average backfat thickness (2.55, 2.76, 2.86, 2.79, and 2.77 cm; quadratic,  $P < 0.09$ ), decreased fat free lean (49.1, 50.3, 47.9, 46.8, and 46.7 kg; linear,  $P < 0.03$ ), and had a quadratic effect (74.2, 74.7, 75.8, 74.2, and 74.2,  $P < 0.04$ ) on dressing percentage. The RBC had no effect ( $P > 0.10$ ) on any remaining carcass traits. In Exp 2, there was a quadratic effect (2.57, 2.30, 2.57 cm,  $P < 0.07$ ) of RBC addition on average backfat thickness. There was no effect

of RBC addition ( $P > 0.10$ ) on any other response variable. In Exp 3, the RBC addition linearly decreased average backfat thickness (3.20, 3.11, and 2.94 cm,  $P < 0.04$ ) and increased large intestine percentage (1.03, 1.16, and 1.17,  $P < 0.09$ ) of final BW. There was no effect of RBC addition ( $P > 0.10$ ) on any other response variable. Our results suggest that feeding 3 or 4% RBC decreases growth performance of finishing pigs, but that 1 or 2% RBC addition in the diets had no detrimental effect. There were no consistent positive or negative effects of RBC addition on carcass traits or viscera weights.

**Key Words:** finishing pigs, carcass, red blood cells

**186 Evaluation of an encapsulated fortified nutrient pack (FNP) on growth performance and apparent total tract nutrient digestibility in growing-finishing pigs.** V. D. Naranjo\*<sup>1</sup>, T. D. Bidner<sup>1</sup>, S. L. Johnston<sup>2</sup>, R. E. Musser<sup>3</sup>, and L. L. Southern<sup>1</sup>, <sup>1</sup>LSU Agricultural Center, Baton Rouge, LA, <sup>2</sup>Hubbard Feeds Inc., Mankato, MN, <sup>3</sup>Soda Feed Ingredients, LLC, Mankato, MN.

Two experiments (Exp.) evaluated the effect of an encapsulated FNP on growth performance and apparent total tract digestibility of DM, CP, and GE in growing-finishing pigs. The FNP contained: fumaric, malic, citric, phosphoric, and lactic acids, L-carnitine, chromium picolinate, inulin, d-pantothenic acid, and niacin. Pigs ( $n = 54$  barrows; BW = 50 kg [Exp. 1] or  $n = 36$  barrows and 36 gilts; BW = 85 kg [Exp.2]) were randomly assigned (Exp. 1) or blocked by initial BW and sex (Exp. 2) to 3 dietary treatments with 6 reps per treatment. Diets were formulated to contain 0.80 (Exp. 1) or 0.50% (Exp. 2) total Lys and were fed from d 0 to 14 or 28. Fecal samples were collected on the last 3 d of each collection period and combined within day, pig, and pen. Chromic oxide and acid insoluble ash at 0.5 and 1%, respectively, (Exp. 1) or chromic oxide at 0.5% (Exp. 2) were added to the diets as digestibility markers. In both Exp., treatments were a corn soybean meal diet with 0, 0.25, 0.35% FNP. In Exp. 1, the inclusion of FNP did not affect ( $P > 0.1$ ) growth performance or total tract digestibilities of DM, GE, or CP. However, DM (85.4, 84.6, and 84.1%) and GE (82.1, 81.2, and 80.2%) digestibilities were linearly decreased ( $P < 0.06$ ) with FNP supplementation. In Exp. 2, FNP addition did not affect ( $P > 0.1$ ) growth performance of pigs during d 0 to 14 or d 14 to 28. From d 0 to 14, DM digestibility was linearly increased ( $P = 0.07$ ) with the inclusion of FNP; however, there was no effect on CP or GE digestibility. From d 14 to 28, there were linear ( $P < 0.04$ ) and quadratic ( $P < 0.02$ ) effects in CP (72.4, 81.6, and 79.0%) and GE (64.9, 76.2 and 72.0%) digestibilities with the inclusion of FNP, but no difference ( $P > 0.1$ ) in DM digestibility. The inclusion of 0.25% FNP improved nutrient digestibility but there was no further improvement at the 0.5% addition. In summary, the inclusion of 0.25 or 0.50% encapsulated FNP did not improve growth performance of growing-finishing pigs but improved CP and GE digestibilities during the last 14 to 28 d of the Exp.

**Key Words:** digestibility, finishing pigs, organic acids

**187 Effects of decreasing or increasing sow feed intake prior to farrowing on lactation performance.** D.W. Rozeboom\*<sup>1</sup>, R.D. Goodband<sup>2</sup>, K.J. Stalder<sup>3</sup>, and NCERA-89 Committee on Swine Management<sup>4</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>Kansas State University, Manhattan, <sup>3</sup>University of Tennessee, Knoxville.

A study was conducted to determine the effect of a gradual decrease or increase in feed intake pre-farrowing on sow and litter performance during lactation. An unbalanced randomized incomplete block design was used; with 155 multiparous sows and three gestational feeding

regimens. Feeding regimens included: Control, fed 1.81 kg/d from breeding to parturition; Step-down, fed 1.81 kg/d from breeding to d 75 of gestation, 2.72 kg/d from d 76 to 108, 2.37 kg/d on d 109, 1.81 kg/d on d 110, 1.36 kg/d on d 111 to 113, and 0.91 kg/d from d 114 to parturition; and Step-up, fed 1.81 kg/d from breeding to d 85, then 2.72 kg to parturition. All treatments were planned to provide an equal total amount of feed (235 kg) during a 115-d gestation. Sows were moved from gestation to farrowing rooms following feeding on d 107. There were no differences in sow gestation BW on d 0, 85, and 107. Sow weight loss from d 107 of gestation to d 0 of lactation (post-parturition) was greater ( $P < 0.001$ ) with the Step-down treatment than with Control or Step-up treatments ( $16.7 \pm 2.7$ ,  $8.6 \pm 2.8$  and  $6.2 \pm 2.7$  kg, respectively). No incidence of hypogalactia was recorded. Prewaning piglet survival was similar. Feed intake during lactation (6.65, 6.61, or 6.37 kg/d for Control, Step down, and Step up, respectively) did not differ among treatments, but Step-up sows gained less BW in lactation than did Control or Step-down sows ( $P = 0.02$ ;  $3.8 \pm 3.8$ ,  $10.6 \pm 3.8$ , and  $10.1 \pm 3.8$  kg, respectively). Control sows tended to be heavier at weaning than Step-down or Step-up sows ( $P = 0.09$ ;  $226 \pm 8.9$ ,  $215 \pm 8.9$ , and  $218 \pm 8.7$ ). Sow backfat depth, litter growth rate and sow postweaning rebreeding performance were unaffected by treatment. In the subsequent parity after treatment, Step-down sows tended ( $P = 0.10$ ) to have fewer piglets born alive than Control or Step-up sows ( $P = 0.10$ ;  $10.15 \pm 0.82$ ,  $11.24 \pm 1.12$ , and  $12.10 \pm 0.78$ , respectively). In this study, decreasing or increasing feed intake in late gestation resulted in small differences in sow peri-lactation BW measures, but did not affect traditional measures of sow lactation productivity.

**Key Words:** sows, feed intake, production

**188 Supplementing sow diets with N-Take during lactation increases feed intake.** C. L. Bradley\*<sup>1</sup>, J. W. Frank<sup>1</sup>, C. Zier<sup>2</sup>, C. V. Maxwell<sup>1</sup>, R. D. Boyd<sup>2</sup>, and D. McKilligan<sup>3</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>The Hanor Company, Inc., Franklin, KY, <sup>3</sup>TechMix, Inc., Stewart, MN.

Across the swine industry, litter size continues to increase. Subsequently, developing technologies that can increase sow feed intake and milk output during lactation is necessary. In order to address this issue, two studies were completed evaluating the impact of the commercial product N-Take on sow lactation feed intake and litter performance. Sows were fed control diets (CON) formulated to meet or exceed all nutrient requirements or the control diet supplemented with N-Take (0.25% replacing corn). In experiment 1, 60 sows (GPK35, BW = 280.5 kg, and parity = 2.3) were fed a CON or N-Take diet ad libitum throughout lactation (20 d) with litter size standardized to 12.3 pigs/litter within 24 hr of farrowing. N-Take supplementation increased total feed intake (120.0 vs 108.2 kg,  $P = 0.05$ ) and ADFI (6.0 vs 5.4 kg,  $P = 0.04$ ) compared to CON sows; however, lactation weight loss was not different (15.5 vs 12.2 kg,  $P = 0.30$ ). Litter weaning weight (63.1 vs 55.2 kg,  $P = 0.02$ ) and average piglet weight at weaning (6.3 vs 5.7 kg,  $P = 0.01$ ) were greater in N-Take compared to CON sows, while there were no differences in preweaning mortality ( $P = 0.94$ ). In experiment 2, 340 sows (PIC Camborough Product, BW = 216.4 kg, and parity = 1.3) were fed a CON or N-Take diet throughout lactation (21 d) with litter size standardized to 11.8 pigs/litter within 24 hr of farrowing. N-Take supplementation increased total feed intake (124.8 vs 101.7 kg,  $P < 0.001$ ) and ADFI (5.9 vs 4.9 kg,  $P < 0.001$ ) compared to CON sows; however, lactation weight loss between the two treatments was not different (17.8 vs 19.0 kg,  $P = 0.43$ ). Litter weaning weight (61.0 vs 57.8 kg,  $P = 0.08$ ) and litter weight gain (44.1 vs 40.9 kg,  $P = 0.08$ ) were greater for N-Take compared to CON sows, while there were no differences in preweaning

mortality ( $P=0.90$ ). We conclude that N-Take supplementation increases lactation feed intake and litter weaning weights.

**Key Words:** sow, lactation, feed intake

**189 Does the heavier weaning weights of modern pigs affect their iron requirement?** J. S. Jolliff\* and D. C. Mahan, *The Ohio State University, Columbus.*

Three experiments evaluated the relationship of pig weaning weight to hematological and postweaning performance responses. The first experiment evaluated hemoglobin (Hb) and hematocrit (Hct) values of 346 pigs at weaning (17 d), after receiving 200 mg Fe at birth. There was a linear decline ( $P < 0.01$ ) in Hb concentration (from an avg. 12.2 to 10.8 g/dL) and Hct (from an avg. 40 to 34%) as weaning weight increased. The second experiment used 271 pigs to evaluate if the quantity and timing of injected Fe could affect Hb or Hct measurements or weaning weight. Treatments were: 1) 200 mg Fe at birth, 2) 300 mg Fe at birth, and 3) 200 mg Fe at birth + 100 mg at 10 d of age. The 2 treatment with 300 mg of Fe injected resulted in greater ( $P < 0.01$ ) Hb and Hct values at weaning but did not affect pig weaning weight. A third experiment was a  $2 \times 3$  factorial in a RCB design conducted in 6 replicates using 180 pigs. The experiment evaluated the effects of injecting all pigs with 200 mg Fe at birth, but at 10 d injecting either saline or 100 mg Fe. Postweaning diets were conventional nursery diets fed in 3 phases for a 35 d period, but fortified with 0, 80, or 160 mg Fe/kg diet. The greater injected Fe (200+100 mg) group had similar weaning weights as the 200 mg Fe group but greater ( $P < 0.01$ ) Hb and Hct values until 21 d postweaning ( $P < 0.05$ ), whereupon Hb concentrations were similar. Pig Hct increased with increasing dietary Fe by 14 d postweaning ( $P < 0.01$ ). There was an increase ( $P < 0.01$ ) in ADG from d 21 to 35 and d 0 to 35 d ( $P < 0.01$ ) as dietary Fe level increased. Daily feed intake from d 21 to 35 ( $P < 0.05$ ) and G:F ( $P < 0.05$ ) for d 0 to 35 increased as dietary Fe increased. These data indicate that Hb and Hct were lower in heavier weight pigs at weaning, but weaning weights were not different when 200 or 300 mg Fe were injected in nursing pigs. However, nursing pigs receiving 300 mg Fe had greater blood Hb and Hct values during the initial 14 d postweaning implying a greater Fe requirement to maintain normal hematological values. Added dietary Fe (160 mg/kg) enhanced postweaning pig growth responses.

**Key Words:** hemoglobin, iron, pig

**190 Effects of an organic copper source on growth performance and tissue copper concentration in nursery pigs.** J. Zhao\*<sup>1</sup>, R. J. Harrell<sup>1</sup>, G. Allee<sup>2</sup>, B. Hinson<sup>2</sup>, P. Winkelbauer<sup>1</sup>, C. Atwell<sup>1</sup>, J. D. Richards<sup>1</sup>, and M. Vazquez-Anon<sup>1</sup>, <sup>1</sup>*Novus International Inc, St. Charles, MO*, <sup>2</sup>*University of Missouri, Columbia.*

The objective of this study was to investigate the benefits of an organic Cu source on growth performance in nursery pigs. A total of 504 weaned pigs (20 d of age,  $6.28 \pm 0.06$  kg BW) was allotted to one of four treatments with 6 replicates per treatment and 21 pigs per pen. The treatments were a negative control (Trt1), 250ppm CuSO<sub>4</sub> (Trt 2), and 25% or 50% of Cu replaced with Mintrex<sup>®</sup> Cu (Trt 3 and 4, respectively). Pigs fed Mintrex<sup>®</sup> Cu were heavier than those fed the negative control and CuSO<sub>4</sub> was intermediate, with final body weights of 12.20, 12.74, 12.87, 13.09 kg for treatment 1-4, respectively ( $P=0.07$ ). Cu supplementation increased ADG 32% in phase I (d 0-7,  $P=0.06$ ) and 16% overall

( $P=0.05$ ). In addition, Mintrex<sup>®</sup> Cu increased ADFI 13% compared to the negative control in d 7-20, while CuSO<sub>4</sub> was intermediate ( $P=0.06$ ). Feed efficiency was improved with Cu supplementation in the first week of the trial (0.78, 0.89, 0.84, and 0.91 kg/kg for treatment 1-4, respectively,  $P=0.0004$ ). Supplementation of Cu doubled liver Cu ( $P=0.002$ ) and increased jejunum Cu concentration 49% ( $P=0.05$ ). Pigs fed Mintrex<sup>®</sup> Cu at 50% (19.59 ppm) had higher liver Cu than pigs fed negative control (5.38ppm), while CuSO<sub>4</sub> was intermediate (13.85ppm,  $P=0.01$ ). These results suggest that Mintrex<sup>®</sup> Cu was more bioavailable than CuSO<sub>4</sub>. Based on these results, a second trial was designed to investigate whether Mintrex<sup>®</sup> Cu can be used to replace CuSO<sub>4</sub> at lower level. A total of 450 weaned pigs (19 d of age,  $5.66 \pm 0.32$  kg BW) were allotted to one of three treatments with 6 replicates per treatment and 25 pigs per pen. The treatments were a negative control, CuSO<sub>4</sub> at 250 ppm, and Mintrex<sup>®</sup> Cu at 50ppm. During d 22-42, Cu supplementation improved ADG ( $P=0.03$ ) and GF ( $P=0.002$ ), with ADG of 0.453, 0.500, and 0.503kg, and GF of 0.641, 0.685, and 0.678 for the control, CuSO<sub>4</sub>, and Mintrex<sup>®</sup> Cu, respectively. Overall, Cu supplementation tended to improve GF, with 0.675, 0.703, and 0.706 for the control, CuSO<sub>4</sub>, and Mintrex<sup>®</sup> Cu, respectively ( $P=0.07$ ). In summary, Mintrex<sup>®</sup> Cu could be used to replace CuSO<sub>4</sub> at a lower level and maintain similar performance in nursery pigs.

**Key Words:** copper, organic trace mineral, pig

**191 North American Swine Energy System: Introduction.** J. E. Pettigrew\*<sup>1</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, H. H. Stein<sup>1</sup>, D. Y. Kil<sup>1</sup>, A. D. Beaulieu<sup>3</sup>, R. B. Hinson<sup>2</sup>, and F. Ji<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*Prairie Swine Centre, Saskatoon.*

Energy is the most expensive dietary essential in pig diets, but it receives much less attention in North America than is deserved by its importance. In North America it is usually expressed as either DE or ME, but these systems share important shortcomings. They systematically overvalue fibrous or high-protein feedstuffs and they systematically undervalue fats. These shortcomings seriously limit the precision of formulations the industry needs to ensure high production while limiting costs and environmental impact. It is increasingly apparent to many practicing nutritionists that these deficiencies in measurement of dietary energy are important to the economics of pig production. To improve upon DE and ME, it is logical to move to a net energy (NE) system. There are two recently developed NE systems for swine now in use in Europe, the INRA system in France and the CVB system in the Netherlands, and a theoretically-based Potential Physiological Energy (PPE) system has been developed in Denmark. However, for various reasons they have not captured the confidence of many North American swine nutritionists for use in our conditions. As we refine energy systems to the NE level, it becomes apparent that expression of an energy value for feeds is theoretically inadequate because animal factors influence the efficiency of energy use. To address the need for a more sophisticated energy system for North American producers, we have undertaken a multi-year multi-institutional research program under the leadership of the National Pork Board and the United Soybean Board. The objectives are to determine whether any of 3 European energy systems is adequate for use in North American conditions, and whether a sound energy system must consider animal factors such as protein versus fat deposition. This symposium is a report of that research.

**Key Words:** swine, energy, net energy

**192 The importance of advancing our understanding and application of energy systems.** J. F. Patience<sup>\*1,2</sup>, G. L. Allee<sup>3</sup>, F. Ji<sup>4</sup>, R. B. Hinson<sup>3</sup>, D. Y. Kil<sup>4</sup>, H. H. Stein<sup>4</sup>, L. L. Stewart<sup>4</sup>, J. E. Pettigrew<sup>4</sup>, and A. D. Beaulieu<sup>1</sup>, <sup>1</sup>*Prairie Swine Centre, Saskatoon, SK Canada*, <sup>2</sup>*Iowa State University, Ames*, <sup>3</sup>*University of Missouri, Columbia*, <sup>4</sup>*University of Illinois, Urbana*.

Energy is a unique component of the pig's diet, in that it really is not a nutrient like amino acids, vitamins or minerals. Energy is supplied by 3 distinct and unique components of the diet: lipid, protein and carbohydrate. Thus, energy is a complex subject; one of the most challenging aspects is the development of a system that adequately quantifies the content of energy in a diet. Energy systems fill two roles. They serve as the basis for trading of ingredients by characterizing their available energy content. They also provide a platform for diet formulation, supporting the formulation of diets that will meet the pig's needs for maintenance and productive function(s) at the lowest possible cost. The adoption of any specific energy system assumes compatibility with both functions. In North America, DE and ME systems have prevailed; in Europe, the net energy system has been adopted more widely. It is generally accepted that the NE system has advantages over DE and ME in terms of defining the relative energy content of ingredients and thus their economic value. There is much less agreement on which system has the greatest capability for diet formulation, achieving desired or predictable animal productivity outcomes most effectively. There is a clear need for additional research on this latter topic, as it is central to the advancement of our understanding of all of the available energy systems. Most critically, energy is becoming increasingly costly to the global pork industry, and the relative contributions of starch, protein and lipid to this energy supply is changing. As the North American pig industry continues to move towards increased use of by-product ingredients, questions surrounding energy and diet formulation are certain to increase. Remaining competitive in the global food marketplace will depend on our ability to answer these questions.

**Key Words:** swine, energy systems

**193 North American Swine Energy System: Experimental strategy and methods.** G. L. Allee<sup>\*1</sup>, R. B. Hinson<sup>1</sup>, J. E. Pettigrew<sup>2</sup>, J. F. Patience<sup>3</sup>, H. H. Stein<sup>2</sup>, D. Y. Kil<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, F. Ji<sup>2</sup>, and L. L. Stewart<sup>2</sup>, <sup>1</sup>*University of Missouri, Columbia*, <sup>2</sup>*University of Illinois, Urbana*, <sup>3</sup>*Prairie Swine Centre, Saskatoon, Saskatchewan Canada*.

A series of 16 experiments using 703 barrows was conducted to determine if any of the 3 European energy systems is adequate for use under North American conditions, and if a sound energy system must consider animal factors (e.g., protein vs. fat deposition). These experiments were conducted at the University of Illinois, the University of Missouri and the Prairie Swine Centre. Extreme care was taken to assure that similar procedures were used at all 3 locations. In addition, a central laboratory was used by all 3 locations for several analyses in order to minimize variation.

All experiments used the comparative slaughter method to determine NE by measuring the amount of energy retained in the pig carcass during the 28 d (growing) or 35 d (finishing) experiments. Each pig slaughtered was ground multiple times to obtain a representative sample. There were 16 pigs in each initial slaughter group and 8 pigs in each treatment group at each stage of growth. The amount of energy retained during the experimental feeding period was determined by difference. The operational maintenance requirement was estimated by regression of energy retained on energy intake with 4 levels of feed intake at 2 growth stages (approximately 23 to 85 kg) and at the 3 locations. In

all experiments pigs were housed individually in environmentally controlled buildings and weighed weekly. In the maintenance experiments pigs were provided their daily feed allowance in 2 equal meals and water was available at all times. Fecal samples were collected weekly from each pig and pooled to determine digestibility of nutrients by the indicator method. We determined the NE values of specific ingredients using the substitution method and comparative slaughter at 2 stages of growth with ad libitum feeding. In each case ingredients and diets were analyzed to allow calculation of predicted energy values using the nutrient-based European systems. Subsequent speakers will discuss each project in greater detail.

**Key Words:** net energy, pigs

**194 Net energy requirements for maintenance in growing and finishing pigs.** D. Y. Kil<sup>\*1</sup>, F. Ji<sup>1</sup>, R. B. Hinson<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, L. L. Stewart<sup>1</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, J. E. Pettigrew<sup>1</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*Prairie Swine Centre, Saskatoon, SK, Canada*.

An experiment was conducted to estimate the operational NE requirement for maintenance (ONEm) for growing and finishing pigs and to investigate if ONEm is different among pigs kept at different locations. The experiment was conducted at the University of Illinois (UIUC), the University of Missouri (MO), and the Prairie Swine Centre (PSC). Forty eight growing (initial BW: 23 kg) and 48 finishing (initial BW: 83 kg) barrows were used at each location. Within each stage of growth and location, pigs were allotted to 8 outcome groups of 6 pigs according to BW and pigs in each outcome group were then randomly allotted to 1 of 6 treatment groups. Two treatment groups served as an initial slaughter group and all pigs in these 2 groups were harvested at the start of the experiment. The remaining pigs were assigned to 4 dietary treatments and slaughtered after 28 (growing pigs) or 35 d (finishing pigs). Growing pigs at all locations and finishing pigs at MO and PSC were fed 1.40, 1.90, 2.40, or 2.90 times the estimated requirement of ME for maintenance (MEM), but finishing pigs at UIUC were fed 1.85, 2.20, 2.55, or 2.90 times MEM. The daily MEM was assumed to be 191 kcal/kg BW<sup>0.6</sup>. Energy retention in each pig was calculated using the comparative slaughter method. Linear regression analyses were used to estimate the ONEm for each pig, which was defined as the y-intercept for the regression line. The slope of the regression line was assumed to represent the efficiency (NE:DE) of energy utilization in each pig. Results showed that the daily ONEm was different ( $P \leq 0.05$ ) among locations and greater ( $P \leq 0.05$ ) for finishing pigs than for growing pigs (219, 123, and 270 vs. 128, 115, and 78 kcal/kg BW<sup>0.6</sup> for growing and finishing pigs at UIUC, MO, and PSC, respectively). The NE:DE were different ( $P \leq 0.05$ ) among stations and between growing and finishing pigs (0.56, 0.41, and 0.46 for growing pigs and 0.72, 0.54, and 0.78 for finishing pigs at UIUC, MO, and PSC, respectively). These results show that ONEm and NE:DE are not consistent among pigs kept at different locations and also depend on the stage of growth of the pigs.

**Key Words:** maintenance requirement, net energy, pigs

**195 Effects of dietary lipids on net energy of corn in diets fed to growing and finishing pigs.** D. Y. Kil<sup>\*1</sup>, F. Ji<sup>1</sup>, R. B. Hinson<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, L. L. Stewart<sup>1</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, J. E. Pettigrew<sup>1</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*Prairie Swine Centre, Saskatoon, SK, Canada*.

The effect of dietary lipids on the NE of corn in diets fed to growing and finishing pigs was measured. Forty eight growing and 48 finishing bar-

rows (initial BW: 27 and 86 kg, respectively) were allotted to 8 outcome groups of 6 pigs based on BW. Within each outcome group, pigs were randomly allotted to 1 of 6 treatment groups. Two treatments at each stage of growth served as an initial slaughter group. The remaining pigs were assigned to 4 different diets, housed individually, and harvested after 28 (growing pigs) or 35 d (finishing pigs). At each stage of growth, a low lipid basal diet containing corn and soybean meal and no added lipids and a high lipid basal diet containing corn and soybean meal and 8% soybean oil were formulated. Two additional diets were formulated by mixing 75% of each basal diet and 25% corn. Energy retention in each pig was calculated using the comparative slaughter method. Results showed that supplemental lipids had no effect on ADG, ADFI, and G:F of growing pigs, but improved ( $P \leq 0.01$ ) G:F for finishing pigs. The addition of corn increased ( $P \leq 0.05$ ) ADFI, but decreased ( $P \leq 0.05$ ) G:F for growing pigs, but there was no effect of the addition of corn on ADG, ADFI, and G:F for finishing pigs. For growing pigs, corn tended to increase ( $P \leq 0.10$ ) lipid gain:protein gain and energy retention but dietary lipids had no effect on lipid gain:protein gain or energy retention. For finishing pigs, lipid gain, lipid gain:protein gain, and energy retention were not influenced by the addition of dietary lipids or corn. The NE of diets containing supplemental lipids was greater ( $P \leq 0.01$ ) than the NE of diets containing no supplemental lipids. No effect of additional corn on NE of diets was observed. The NE of corn in the diet containing supplemental lipids (2,053 kcal/kg) was not different from the NE of corn in the diet containing no supplemental lipids (2,197 kcal/kg). The NE of corn was greater ( $P \leq 0.05$ ) for finishing pigs (2,607 kcal/kg) than for growing pigs (1,643 kcal/kg). In conclusion, NE of corn is not affected by supplemental lipids, but the NE of corn is greater for finishing pigs than for growing pigs.

**Key Words:** corn, lipids, net energy

**196 Net energy content of commercial and low-oligosaccharide soybean meal.** R. B. Hinson<sup>\*1</sup>, D. Y. Kil<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, L. L. Stewart<sup>2</sup>, J. Fei<sup>2</sup>, J. E. Pettigrew<sup>2</sup>, J. F. Patience<sup>3</sup>, H. H. Stein<sup>2</sup>, and G. L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>University of Illinois, Urbana, <sup>3</sup>Prairie Swine Centre, Saskatoon, SK, Canada.

Two experiments were conducted in order to determine the NE of normal and low-oligosaccharide soybean meal (SBM) in growing and finishing pig diets. Forty growing (initial BW = 26 kg) and 40 finishing (initial BW = 89 kg) barrows were allotted to one of five groups with eight replications based upon initial BW within each growth period. Two groups were randomly selected to serve as an initial slaughter group. The remaining groups were randomly assigned to either a basal, commercial SBM (C-SBM), or low-oligosaccharide SBM (LO-SBM) diet and harvested at the conclusion of the study. Pigs were individually penned and were ad-lib fed for 28 and 35 days for the grower and finishing phases, respectively. The basal diet contained corn, fishmeal, and casein as protein sources, but did not contain any SBM. The test diets were obtained by mixing 75% of the basal diet with 25% of either the C-SBM or LO-SBM. During the growing phase, ADG and G:F were increased ( $P < 0.01$ ) when a source of SBM was added to the basal diet. However, there were no differences in ADG (1.02 vs. 0.96 kg/d) and G:F (0.54 vs. 0.52) between the diets containing C-SBM and LO-SBM, respectively. During the finisher phase, the addition of a SBM source reduced ( $P < 0.05$ ) ADG (1.17 vs. 1.32 kg/d) and ADFI (3.59 vs. 3.94 kg/d) but did not affect G:F ( $P > 0.1$ ) when compared to the basal diet. Apparent total tract digestibility of protein was increased ( $P < 0.001$ ) in both the grower (80.0 vs. 68.3%) and finishing (84.4 vs. 75.5%) phases when a SBM source was added to the basal diet. During the grower phase, lipid accretion (125.5 vs. 187.6 g/d) was reduced ( $P < 0.006$ )

and protein accretion was increased ( $P < 0.05$ ) when a SBM source was added to the basal diet. Protein accretion was higher ( $P < 0.05$ ) in pigs consuming C-SBM (179.5 g/d) when compared to LO-SBM (157.1 g/d). While not statistically different ( $P > 0.05$ ), the NE (DM basis) of LO-SBM was numerically greater than that of C-SBM in both the grower (1,990 vs. 1,634 kcal/kg) and finishing (2,554 vs. 2,150 kcal/kg) periods. The NE of the SBM sources were also numerically greater ( $P > 0.05$ ) in the finishing period than in the growing period.

**Key Words:** pigs, low-oligosaccharide soybean meal, net energy

**197 Net energy of soybean oil and choice white grease in diets fed to growing or finishing pigs.** D. Y. Kil<sup>\*1</sup>, F. Ji<sup>1</sup>, R. B. Hinson<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, L. L. Stewart<sup>1</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, J. E. Pettigrew<sup>1</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>University of Missouri, Columbia, <sup>3</sup>Prairie Swine Centre, Saskatoon, SK, Canada.

An experiment was conducted to determine the NE of 2 sources of dietary lipids by growing and finishing pigs and to evaluate the effects of inclusion rate on the NE of lipids. Soybean oil (SBO) and choice white grease (CWG) was used. Forty eight growing (initial BW: 22 kg) and 48 finishing (initial BW: 84 kg) barrows were used. Within each stage of growth, pigs were allotted to 8 outcome groups of 6 pigs based on BW. Within each outcome group, pigs were randomly allotted to 1 of 6 treatment groups. Two treatment groups at each stage of growth served as an initial slaughter group. Pigs on the remaining treatment groups were randomly allotted to 4 different diets, housed individually, and harvested after 28 (growing pigs) or 35 days (finishing pigs). The basal diet contained corn and soybean meal without supplemental lipids. Three additional diets were formulated by mixing 95% of the basal diet and 5% of SBO, 90% of the basal diet and 10% of SBO, or 90% of the basal diet and 10% of CWG. Energy retention in each pig was calculated using the comparative slaughter method. The NE of SBO and CWG were calculated using the difference procedure. There were no interactions among main effects. Results showed that the NE of diets increased (linear,  $P \leq 0.01$ ) with increasing level of SBO (2,032, 2,186, and 2,292 kcal/kg for diets containing 0, 5, or 10% SBO), but the NE of the diet containing 10% CWG (2,431 kcal/kg) was greater ( $P \leq 0.05$ ) than the NE of the diet containing 10% SBO. The NE of diets was greater ( $P \leq 0.05$ ) for finishing pigs (2,509 kcal/kg) than for growing pigs (1,961 kcal/kg). The NE of SBO was not affected by the inclusion rate (5,102 kcal/kg and 4,619 kcal/kg for SBO included at 5 or 10%, respectively). The NE of CWG (6,017 kcal/kg) was greater ( $P \leq 0.05$ ) than the NE of SBO. The stage of growth had no impact on NE of lipids. In conclusion, the NE of diets increases with the concentration of lipids. The NE of lipids is not affected by the level of dietary lipids, but the NE of CWG is greater than the NE of SBO.

**Key Words:** choice white grease, net energy, soybean oil

**198 Net energy of soybean hulls and wheat middlings in diets fed to growing or finishing pigs.** L. L. Stewart<sup>\*1</sup>, D. Y. Kil<sup>1</sup>, F. Ji<sup>1</sup>, R. B. Hinson<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, J. E. Pettigrew<sup>1</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>University of Missouri, Columbia, <sup>3</sup>Prairie Swine Centre, Saskatoon, SK, Canada.

The objective of this experiment was to measure the NE of soybean hulls (SBH) and wheat middlings (WM) by growing and finishing pigs and to determine if finishing pigs utilize the energy in SBH and WM more efficiently than growing pigs. Forty growing and finishing barrows (initial BW: 25 and 85 kg, respectively) were randomly allotted to 5 treatment groups within each stage of growth. Two treatment groups at each

stage of growth served as the initial slaughter group and were harvested at the start of the experiment. Pigs on the remaining 3 treatment groups were randomly allotted to 3 dietary treatments (basal diet, SBH, or WM), housed individually, and harvested after 28 (growing pigs) or 35 days (finishing pigs). The basal diet contained corn and soybean meal and the SBH and WM diets were formulated by mixing 70% of the basal diet and 30% of SBH or 30% of WM. The retention of energy in each pig was calculated using the comparative slaughter procedure. The NE of SBH and WM were subsequently calculated using the difference procedure. In growing pigs, the NE of the basal diet (1,872 kcal/kg) was greater ( $P \leq 0.01$ ) than the NE of the diets containing SBH (1,355 kcal/kg) or WM (1,516 kcal/kg), but the NE of SBH (149 kcal/kg) was not different from the NE of WM (684 kcal/kg). In finishing pigs, the NE of the basal diet (2,425 kcal/kg) was greater ( $P \leq 0.05$ ) than the NE of the diets containing SBH (1,998 kcal/kg) or WM (2,068 kcal/kg). The NE of SBH (1,000 kcal/kg) was similar to the NE of WM (1,233 kcal/kg). The NE of diets (2,033 vs. 1,435 kcal/kg) and of ingredients (1,116 vs. 416 kcal/kg) were greater ( $P \leq 0.05$ ) for finishing than for growing pigs. In conclusion, the NE of diets decreases with the inclusion of SBH or WM. The NE of SBH is similar to the NE of WM for both growing and finishing pigs, but the NE of SBH and WM for finishing pigs is greater than for growing pigs.

**Key Words:** net energy, soy hulls, wheat middlings

**199 Reduced dietary crude protein impacts growth performance, carcass nutrients and energy metabolism in growing and finishing pigs.** A. D. Beaulieu<sup>\*1</sup>, G. L. Allee<sup>2</sup>, F. Ji<sup>3</sup>, R. B. Hinson<sup>2</sup>, D. Y. Kil<sup>3</sup>, H. H. Stein<sup>3</sup>, L. L. Stewart<sup>3</sup>, J. E. Pettigrew<sup>3</sup>, and J. F. Patience<sup>1,4</sup>, <sup>1</sup>*Prairie Swine Centre, Saskatoon, SK, Canada*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*University of Illinois, Urbana*, <sup>4</sup>*Iowa State University, Ames*.

Pressure on the cost and availability of dietary energy has increased the need for information on energy metabolism. This experiment evaluated the impact of low protein diets on energy utilization in the growing and the finishing pig. Growing (ave. initial wt 25.3±0.3 kg) and finishing (ave. initial wt. 77.3±0.9 kg) pigs were used in a serial slaughter study of 28 and 35d for the growing (GEX) and finishing (FEX) experiments, respectively. The two experimental treatments contained 22.0% and 17.9% CP in GEX or 16.0% and 12.5% CP in FEX. Diets were formulated with constant net energy across treatments within experiment. In total, 32 barrows were employed in each experiment: 16 in the initial slaughter group and 8 per dietary treatment. In GEX, reduced CP had no effect on ADG or ADFI ( $P > 0.10$ ), but lowered G:F (0.6 vs 0.5;  $P < 0.05$ ). It also lowered carcass water (70.0 vs 66.4%) and increased fat (10.9 vs 15.0%;  $P < 0.01$ ), but had no effect on CP or ash ( $P > 0.10$ ). The quantity of energy retained in the carcass increased on the low CP diet (53.6 vs 71.9 Mcal;  $P < 0.05$ ). In FEX, reduced CP no effect on growth performance ( $P > 0.10$ ) but it decreased the concentration of carcass fat (25.7 vs 22.5%;  $P = 0.05$ ) and tended to reduce the concentration of water (58.2 vs 56.3%;  $P < 0.10$ ). Diet had no effect on carcass CP or ash ( $P > 0.10$ ). The quantity of energy retained in the carcass decreased (159.2 vs 123.8 Mcal) on the low CP diet ( $P < 0.05$ ). Dietary net energy, calculated from operational maintenance plus retained energy, was 1982, 1855 and 1775 and 2028 kcal/kg, for the low and high CP diets in GEX and FEX respectively. Utilization of energy is altered by lowering dietary crude protein, reflecting changes in the composition of gain not necessarily observed in total body growth performance.

**Key Words:** pigs, low protein diets, energy

**200 Comparison of measured values for NE in diets and ingredients fed to pigs and values predicted from European energy systems.**

D. Y. Kil<sup>1</sup>, F. Ji<sup>1</sup>, R. B. Hinson<sup>2</sup>, A. D. Beaulieu<sup>3</sup>, L. L. Stewart<sup>1</sup>, G. L. Allee<sup>2</sup>, J. F. Patience<sup>3</sup>, J. E. Pettigrew<sup>1</sup>, and H. H. Stein<sup>\*1</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*University of Missouri, Columbia*, <sup>3</sup>*Prairie Swine Centre, Saskatoon, SK, Canada*.

The objective of this study was to compare measured NE values in diets and ingredients fed to growing and finishing pigs with values predicted from 3 European energy systems. Sixteen diets and 6 ingredients were fed to growing and finishing pigs at 3 locations in North America and the NE of each diet and each ingredient was measured using the comparative slaughter method. The 6 ingredients were corn, conventional soybean meal, low-oligosaccharide soybean meal, soybean oil, choice white grease, soybean hulls, and wheat middlings. Regular corn-soybean meal diets and low-protein corn-soybean meal diets fortified with crystalline AA were also used. The measured NE for diets and ingredients were compared with NE values that were predicted from the French NE system (INRA), The Dutch NE system (CVB), and the Danish potential physiological energy system (PPE). Results showed that the measured values for NE of diets were lower ( $P \leq 0.05$ ) than the values predicted from INRA and CVB. This was true for growing pigs as well as for finishing pigs, but values for finishing pigs obtained in this experiment were closer to the values predicted from INRA and CVB than the values for growing pigs. Values obtained for the diets used in this experiment were also closer to values predicted by PPE than the values predicted by INRA and CVB. For ingredients, the measured NE values were lower ( $P \leq 0.05$ ) than the predicted values for growing pigs, regardless of which system they were compared with. However, the measured values for finishing pigs were relatively close to the predicted values from the three European systems. The ranking of the 6 ingredients was similar if based on measured and predicted values. In conclusion, NE values predicted from the INRA and the CVB systems are greater than values for NE that are measured in pigs using the comparative slaughter procedure, but values for PPE are closer to measured values.

**Key Words:** European energy systems, net energy, pigs

**201 Energy and nitrogen balance for pigs receiving mixed-species meat and bone meal in corn-soybean meal based diet.** O. A. Olukosi<sup>\*</sup> and O. Adeola, *Purdue University, West Lafayette, IN*.

Nitrogen and energy balance of pigs receiving 10% meat and bone meal (MBM) from mixed species in corn-soybean meal (SBM) based diets was investigated. Eight treatments consisting of a corn-SBM standard diet (SD) and 7 test diets in which 7 MBM of mixed species origin (ruminants and pork) were added at the rate of 10% to partially replace corn and SBM such that the ratio of corn and SBM was the same in all the diets were used. Crude protein contents of the 7 MBM samples range from 55 to 63%. A total of 72 barrows weighing 30-kg were used for the study. The barrows were allocated to 8 treatments and each treatment had 9 replicates. The barrows were allowed 5 d of adjustment and 5 d of feeding and total collection of feces and urine. All the samples were analyzed for gross energy and N. Digestibility of N was similar across all the diets and was 81.2% on the average. Energy intake, fecal energy loss and energy retained were not different among the eight diets and were on average 6,085, 180 and 5,778 kcal/d, respectively. The urinary energy loss was lowest ( $P < 0.05$ ) in SD (96.6 kcal/d) whereas energy retention as a percentage of intake was highest in SD (95.5%). Nitrogen intake was lowest ( $P < 0.05$ ) in SD (41.9 g/d) and higher but similar in all the diets with MBM samples (52.2 g/d). Fecal and urinary N losses as well as N retention were lowest ( $P < 0.05$ ) in SD being 7.71, 5.32 and

28.8 g/d, respectively. Fecal N loss was greatest in the diet having MBM samples with highest CP content. Although CP as well as individual and total amino acid contents of the MBM were similar, urinary N loss compared to SD was highest in those diets having MBM samples that had lower CP. Nitrogen retention was similar among the diets containing the MBM samples (34.0 g/d) and was higher ( $P < 0.05$ ) than SD (28.8 g/d). Nitrogen retention as a percentage of intake was similar in all the treatments (65.5%) thus indicating the impact of N intake on its utilization. The data from this study indicate that proximate and amino acid compositions of MBM did not strongly influence energy and nitrogen balance in diets in which the feedstuffs are used.

**Key Words:** meat and bone meal, retention, pigs

**202 Effect of Fresta F Concentrate on performance of weanling pigs fed in a commercial environment.** K. Purser<sup>\*1</sup>, T. Weeden<sup>2</sup>, C. Hankins<sup>2</sup>, and K. Wendler<sup>1</sup>, <sup>1</sup>*Delacon Phytogenic Feed Additives, Steyregg, Austria*, <sup>2</sup>*Land O'Lakes Purina Feed, St. Paul, MN*.

Fresta F Concentrate (FFC) is an all-natural feed additive composed of essential oils, herbs, spices and mucilage. Patented micro-encapsulation technology is used to maintain the stability of the essential oils. Previous work in a research setting indicated that pigs fed FFC grew 5 to 6% faster and 3 to 4% more efficiently than those without FFC. The purpose of this experiment was to determine the effect of FFC on the performance of weanling pigs in a commercial environment fed diets formulated to support high performance. The experiment was conducted in a typically designed commercial wean to finish barn (50 pens) equipped and staffed to conduct research. For this trial, 352 pigs weaned at 19 to 21 d and 5.85 kg BW were utilized in 8 replications of 22 pigs/pen (16 pens). Pigs were started on trial as two groups three days apart and were fed standard basal diets in four phases of 7, 6 or 9, 16 and 12 days for Phases 1, 2, 3 and 4, respectively. Phase 1 and 2 diets contained 39 mg/kg tiamulin, 441 mg/kg chlortetracycline, 3,500 mg/kg Zn and 215 mg/kg Cu. Phase 3 diets contained 55 mg/kg carbadox, 1150 mg/kg Zn and 200 mg/kg Cu. Phase 4 diets contained 55 mg/kg carbadox, 140 mg/kg Zn and 200 mg/kg Cu. All diets were fed in pelleted form. Treatments were obtained by adding FFC to provide 200 mg/kg. ADG, ADFI, and feed:gain for the entire study for pigs fed the basal diet vs. those fed FFC supplemented diets were, respectively (449, 454 g/d; 609, 594 g/d; and 1.36, 1.31). Pigs fed diets containing FFC gained weight more efficiently ( $P < 0.05$ ). No performance parameters were different ( $P > 0.10$ ) during Phases 1, 2 and 3. Only feed:gain was improved ( $P < 0.05$ ) during Phase 4, 1.58 vs. 1.47. These results indicate FFC is effective in improving feed:gain in weanling pigs fed high performance diets in a commercial environment. Further research is needed to determine if FFC supplementation is required in early nursery phases to obtain the response observed in the last phase.

**Key Words:** pigs, essential oils, feed efficiency

**203 Effects of PepSoyGen (PSG) and Dried Porcine Solubles 50 (DPS 50) on nursery pig performance.** C. K. Jones<sup>\*</sup>, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz, and R. D. Goodband, *Kansas State University, Manhattan*.

Two experiments were conducted to evaluate the effects of adding fish meal, PSG, or DPS 50 on pig performance. In Exp. 1, weanling 350 pigs (PIC, 6.1 kg BW) were fed a control diet or diets supplemented with 3 or 6% fish meal; 3.75 or 7.50% PSG; or a combination of PSG and DPS 50 with each fed at 1.88% or 3.75% of the diet. There were 10 replications with 5 pigs per pen. From d 0 to 14, pigs fed increasing

PSG with or without DPS 50 had improved ( $P < 0.01$ ) G:F. Pigs fed PSG had improved ( $P = 0.02$ ) G:F compared to pigs fed the control diet. Pigs fed PSG and DPS 50 in combination had improved ( $P < 0.03$ ) ADG compared to pigs fed the control diet or PSG alone and improved ( $P < 0.03$ ) G:F compared to pigs fed the control diet or diets containing fish meal. From d 0 to 35, pigs fed increasing PSG had improved ( $P = 0.03$ ) G:F. In Exp. 2, 252 weanling pigs (PIC, 6.8 kg BW) were fed a control diet or supplemented with 5% fishmeal, 3.5% DPS 50, 6.0% PSG, 1.75% PSG and 1.75% DPS 50, or 3.0% PSG and 2.5% fish meal. There were 7 replications with 6 pigs per pen. From d 0 to 14, pigs fed DPS 50 alone or with PSG had improved ( $P < 0.05$ ) ADG and G:F compared to pigs fed all other diets. Overall (d 0 to 28), pigs fed DPS 50 had improved ( $P = 0.01$ ) ADG (421 vs. 383 g) and G:F (0.77 vs. 0.73) compared to pigs fed the control diet and improved ( $P = 0.03$ ) G:F (0.77 vs. 0.74) compared to pigs fed the combination of PSG and fish meal. In conclusion, pigs fed DPS 50 alone or with PSG had improved performance compared with pigs fed the control diet.

**Table 1.**

		Exp. 1					
		Fish meal		PSG		PSG + DPS50	
d 0 to 14	Control	3%	6%	3.75%	7.50%	1.88 +	3.75 +
						1.88%	3.75%
ADG, g	262	285	256	260	262	293	295
ADFI, g	345	360	314	315	330	351	352
G:F	0.75	0.79	0.80	0.83	0.79	0.84	0.84
		Exp. 2					
		Fish meal		PSG		PSG + DPS50	
						PSG + fish meal	
d 0 to 14	Control	5%	3.5%	6%	1.75+	3.0+	
					1.75%	2.5%	
ADG, g	252	268	313	269	302	255	
ADFI, g	331	356	366	343	355	334	
G:F	0.75	0.75	0.86	0.79	0.85	0.76	

**Key Words:** growth, nursery pig, protein source

**204 Apparent and standardized ileal digestibility values for amino acids in a yeast-derived protein source (NuPro<sup>®</sup>) for 3- to 4-wk-old pigs.** S. Moehn<sup>1</sup>, P. Groenewegen<sup>\*2</sup>, and R. O. Ball<sup>1</sup>, <sup>1</sup>*University of Alberta, Edmonton, Alberta, Canada*, <sup>2</sup>*Alltech Inc., Nicholasville, KY*.

The objective of this experiment was to determine the ileal digestibility of amino acids in yeast extract (NuPro<sup>®</sup>, Alltech Inc.) in 4-wk old piglets. Fifty piglets were weaned at 18 and 19 d of age, from which 30 with the greatest weight gains were selected after 2 d exposure to a control diet. Piglets were allocated to 5 treatments so that gender, age, body weight (BW) and pre-treatment weight gains were equalized. Treatments were: control diet based on wheat, corn starch, soybean meal, casein and whey powder; and the control diet with inclusion of 3%, 6% or 9% NuPro at the expense of corn starch. All diets contained protein-bound amino acids only. The fifth dietary treatment consisted of a protein-free diet. Piglets were housed individually in raised pens in a temperature-controlled room, and offered the diets for 9 d. The protein-free group was fed the control diet until d 7, after which the piglets were switched to the protein-free diet. Pigs were euthanized on d 10 and terminal ileum contents collected. BW, daily gain (DG) and feed intake (FI) before and after allocation to treatments did not differ

( $P > 0.1$ ) between groups. NuPro increased DG and FI by 8.3% over the control and numerically increased the apparent and standardized ileal digestibility of amino acids, except for valine. The difference method was unsuitable to determine the amino acid digestibility in NuPro, probably due to the small contribution of NuPro to the amino acid content in the diet. The regression method yielded mean apparent and standardized ileal digestibility values for amino acids of 75.7% and 84.5%, respectively. Overall, the amino acid digestibility in NuPro was slightly greater than in the control, which contained high-quality protein. The mean apparent and standardized digestibility values for amino acids in NuPro were similar to those previously reported for pigs 6 to 8 wk of age. In conclusion, NuPro is a source of highly digestible amino acids for newly weaned pigs. These data on standardized and apparent ileal digestibility values for NuPro may be used in diet formulation for pigs between 20 and 30 d of age.

**Key Words:** amino acid, weanling, yeast

**205 Effect of spray-dried egg on growth performance of nursery pigs.** M. Song<sup>\*1</sup>, B. G. Harmon<sup>2</sup>, J. A. Soares<sup>1</sup>, M. T. Che<sup>1</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Railsplitter Feed Technology, Wildwood, MO.

An experiment was conducted to evaluate the nutrient contributions and potential health benefits of a spray-dried egg (SDE) product containing only unfertilized eggs as a protein source in complex diets for nursery pigs. Weaned pigs ( $n=160$ ,  $6.7 \pm 1.0$  kg BW, 21d old) were used in a completely randomized design with pen as the experimental unit. There were 40 pens with 10 pens/treatment and 4 pigs/pen. Pigs were randomly assigned to each pen with the same number of barrows and gilts. The treatments were formulated to the same ME and standard ileal digestible amino acid levels, were in a  $2 \times 2$  factorial arrangement (with or without SDE and with or without spray-dried animal plasma (SDAP)), and were 1) Control (CON), 2) CON+SDE (SDE), 3) CON+SDAP (SDAP), and 4) CON+SDE+SDAP (SDEAP). The diets did not include antibiotics or zinc oxide. There was a 4-stage feeding program with declining diet complexity and inclusion rate (6, 4, 2, and 0 %, respectively) of SDE and SDAP and with phases of 1, 1, 2, and 2 weeks, respectively. ADFI, ADG, and G/F were measured. During phase 1, pigs fed SDE or SDAP had higher ( $P < 0.05$ ) ADFI than pigs not fed SDE or SDAP and pigs fed SDAP had higher ( $P < 0.05$ ) ADG and G/F than pigs not fed SDAP. During phases 2, 3, 4, and overall, there were no SDE effects on ADG and ADFI. However, there were negative ( $P < 0.05$ ) SDE effects on G/F in phase 2, 3, and overall. In conclusion, SDE is an efficacious protein source for nursery pigs but no additional benefits are shown in this experiment.

**Table 1. Growth performance**

Item	Treat				SEM	SDE	P-value	
	CON	SDE	SDAP	SDEAP			SDAP	SDE*SDAP
Phase 1								
Pens	10	10	10	10				
ADG, g	50	67	108	120	14	NS	< 0.05	NS
ADFI, g	140	176	181	214	14	< 0.05	< 0.05	NS
G/F	0.34	0.36	0.57	0.55	0.05	NS	< 0.05	NS
Overall								
Pens	10	10	10	10				
ADG, g	423	433	440	427	12	NS	NS	NS
ADFI, g	656	682	662	677	18	NS	NS	NS
G/F	0.65	0.64	0.67	0.63	0.01	< 0.05	NS	NS

NS: No significant difference; 4 pigs/pen

**Key Words:** spray-dried egg, nursery pigs, performance

**206 Evaluation of crude glycerol as a feed ingredient for nursery pigs.** M. Shields\*, E. van Heugten, J. Odle, and C. Stark, North Carolina State University, Raleigh.

This study evaluated the performance of nursery pigs fed crude glycerol as a substitute for lactose in starter 1 diets and for corn in starter 2 diets. The crude glycerol contained 86.95% glycerol, 9.22% moisture, 1.26% sodium, 1.86% chloride, and 280 ppm methanol. Pigs ( $n=126$ ,  $BW=6.91 \pm 0.18$  kg) were weaned at 21 d of age and housed 3 per pen in 42 pens with 7 replicates. Pigs were assigned to one of 6 treatments arranged in a  $2 \times 3$  factorial randomized complete block design. Factors consisted of: 1) glycerol in phase 1 diets (0 or 5%), and 2) glycerol in phase 2 diets (0, 5, or 10%). In phase 1 diets, fed for 14 d, glycerol replaced lactose on a weight-for-weight basis and in phase 2 diets, fed for 21 d, it replaced primarily corn on a least cost basis. Diets were corrected for the added moisture and salt from crude glycerol. Glycerol in starter 1 diets had no effect ( $P > 0.29$ ) on BW, ADG, ADFI or gain/feed. Final BW after 5 wk increased ( $P = 0.03$ ) with increasing glycerol and this effect was greater in pigs previously fed glycerol in starter 1 diets (interaction,  $P = 0.02$ ). ADG was greater in pigs fed glycerol in starter 2 diets during wk 4 ( $P = 0.01$ ), wk 5 ( $P = 0.007$ ), the starter 2 phase ( $P = 0.002$ ) and overall (368, 396, and 412 g/d for 0, 5, and 10% glycerol, respectively;  $P = 0.03$ ), with the overall response being greater in pigs fed 5% glycerol in starter 1 (interaction,  $P = 0.03$ ). Glycerol in phase 2 diets increased ADFI in wk 4 ( $P = 0.04$ ), wk 5 ( $P < 0.001$ ), starter phase 2 ( $P < 0.003$ ), and overall (544, 601, 609 g/d for 0, 5, and 10% glycerol, respectively;  $P = 0.02$ ). Gain/feed was improved with glycerol in phase 2 diets during the starter 2 phase ( $P = 0.04$ ). Serum glycerol did not differ in the starter 1 phase, but increased linearly ( $P < 0.001$ ) and quadratically ( $P < 0.01$ ) with increasing glycerol in the starter 2 phase (6.4, 30.4, 192.7 mg/ml). Results indicate that 5% glycerol in diets immediately following weaning had no effect on pig performance. Glycerol in the second phase improved ADFI, ADG, and gain/feed, with the level of 10% giving the greatest response.

**Key Words:** glycerol, lactose, performance

**207 The effects of extrusion and inclusion of dried distillers grains on amino acid ileal digestibility in swine.** G. A. Apgar<sup>\*1</sup>, P. M. Walker<sup>2</sup>, and R. L. Atkinson<sup>1</sup>, <sup>1</sup>Southern Illinois University, Carbondale, <sup>2</sup>Illinois State University, Normal.

Drying distillers grains with solubles (DGS) releases gaseous emissions, in some cases exceeding EPA emission limits. The greatest release occurs when reducing DGS from 30% to 12% moisture; hence extrusion may be an efficacious manner to dry DGS while reducing gaseous emissions. The objective of this study was to determine the effect of extruded byproducts on standard ileal digestibility of amino acids. Eight male pigs (PIC L337×C22;  $51.2 \pm 3.8$  kg) fitted with steered ileocecal valve cannulas were used in a  $4 \times 4$  repeated Latin square design to determine the effect of diet extrusion and protein source on standard ileal AA digestibility (SID). Pigs were fed a N-free diet during an initial period to determine endogenous loss. Semi-purified dietary treatments were formulated to supply 0.9% lysine. Protein sources included dried DGS (DDGS) either extruded or non-extruded, and a mixture (MIX) of 70:30 soybean meal:DDGS either extruded or non-extruded. Treatments were balanced to meet AA requirements and fed at 9% metabolic body weight offered twice daily (0700 and 1700 h). Each period consisted of a 5 d adjustment, 3 d total fecal and urine collection, followed by 2 12-h ileal collection, with 1 d to rehydrate between ileal collections. Data were analyzed to compare effects of processing (extruded vs. non-extruded) and protein source (DDGS vs 70:30 MIX of soybean meal:DDGS).

Lysine SID was 12% greater ( $P=0.02$ ) for the MIX protein as compared to DDGS fed pigs. Indispensable AA SID values for arginine, histidine, and isoleucine were also greater ( $P \leq 0.05$ ) for pigs consuming MIX compared to pigs consuming DDGS. Additionally, SID was greater ( $P=0.001$ ) for aspartic acid in pigs fed MIX by 16% compared to pigs fed DDGS. Extrusion of the MIX diet decreased ( $P=0.02$ ) SID of proline compared to the non-extruded MIX diet. However, SID of all AA were not affected ( $P \geq 0.42$ ) by processing of DDGS. Therefore, these data suggest extrusion does not influence overall SID values for indispensable and dispensable AA; however, adding soybean meal to DDGS improves AA SID values regardless of processing technique.

**Key Words:** dried distillers grain, extrusion, swine

**208 Metabolizable energy content of feed-grade glycerin for growing pigs and its effect on growth performance, carcass characteristics and pork quality traits.** O. M. Mendoza\*<sup>1</sup>, M. Ellis<sup>1</sup>, F. K. McKeith<sup>1</sup>, and A. M. Gaines<sup>2</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>The Maschhoffs, Carlyle, IL.

Two studies were conducted to determine the metabolizable energy (ME) content of feed-grade glycerin (99.7% USP) and its effects on growth performance, and carcass and meat quality measures. An energy balance study was carried out to measure the apparent ME of glycerin using 24 barrows ( $21.5 \pm 0.60$  kg BW), in a RCBD with 2 treatments: 1) Control (99.85% corn + vitamins and minerals); 2) Glycerin (30% of corn replaced with feed-grade glycerin). A 7-d adaptation was followed by a 5-d period for the collection of feces and urine. Gross energy of diets, feces and urine was determined by bomb calorimetry. The DE content of the Glycerin diet was greater ( $P < 0.01$ ) than that of the Control diet (4,298 vs. 3,902 kcal/kg DM, respectively). However, there was no difference ( $P > 0.05$ ) in ME content of the Control and Glycerin diets (3,820 vs. 3,723 kcal/kg DM). The ME of glycerin (estimated by difference) was 3,500 kcal/kg DM. A growth study was carried out with 128 gilts housed in groups of 4 and reared from  $92.5 \pm 2.6$  kg BW for a 28-d feeding period, using a split-plot design with a  $4 \times 2$  factorial arrangement of the following treatments: 1) dietary glycerin level (0, 5, 10 and 15%) and 2) pre-slaughter handling (gentle vs. intense). At the end of the 28-d period, 50% of the pigs from each pen were subjected to one of the two handling treatments prior to harvest after which carcass and pork quality measurements were taken. There were no interactions between glycerin level and pre-slaughter handling. Glycerin had no effect ( $P > 0.05$ ) on growth performance, carcass measures or meat quality. The intense pre-slaughter handling resulted in softer muscle ( $P < 0.05$ ), and tended to increase ( $P = 0.07$ ) drip loss of the Longissimus. In conclusion, including glycerin at up to 15% of the diet had no effect on growth performance or carcass and meat quality measures. Intense handling of pigs immediately prior to harvest can have a negative impact on pork quality.

**Key Words:** glycerin, pre-slaughter handling, pigs

**209 Effect of dietary level of distillers dried grains with solubles (DDGS) and of Paylean on the growth performance, carcass characteristics, and meat quality parameters of finishing pigs.** C. L. Puls\*<sup>1</sup>, M. Ellis<sup>1</sup>, B. A. Peterson<sup>1</sup>, F. K. McKeith<sup>1</sup>, J. Killefer<sup>1</sup>, A. M. Gaines<sup>2</sup>, B. F. Wolter<sup>2</sup>, M. J. Ritter<sup>3</sup>, and S. N. Carr<sup>3</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>The Maschhoffs, Carlyle, IL, <sup>3</sup>Elanco Animal Health, Greenfield, IN.

This study investigated the effect of dietary level of distillers dried grains with solubles (DDGS) and Paylean on the growth performance,

carcass characteristics, and meat quality parameters of finishing pigs. A RCBD was used with a  $5 \times 2$  factorial arrangement of the following treatments: 1) DDGS level (0, 15, 30, 45, and 60%) and 2) Paylean level (0 and 5 ppm). A total of 240 pigs were housed in groups of 8 (30 pens) for a 28-d feeding period (105.9 to 131.5 kg BW) at the end of which the 4 pigs/pen (2 barrows and 2 gilts) with live weights nearest to the pen mean were selected for carcass and meat quality evaluation. Paylean increased ( $P < 0.05$ ) ADG (0.82 vs. 1.00 kg/d for 0% DDGS No Paylean and Paylean, respectively; 0.95 vs. 0.97 kg/d for 60% DDGS No Paylean and Paylean, respectively) and G:F (0.31 vs. 0.37 kg:kg for 0% DDGS Paylean and No Paylean, respectively; 0.31 vs. 0.31 kg:kg for 60% DDGS Paylean and No Paylean, respectively; SEM = 0.061) in pigs fed 0 and 15% DDGS but not at higher DDGS inclusion levels. Paylean increased ( $P < 0.05$ ) carcass weight (97.8 vs.  $100.0 \pm 0.87$  kg), yield (74.7 vs.  $75.4 \pm 0.27$  %), and lean content ( $52.3$  vs.  $52.8 \pm 0.21$  %). Belly flop distance decreased ( $P < 0.05$ ) with increasing DDGS level (10.9, 8.7, 7.4,  $7.7, 7.4 \pm 0.64$  cm for 0, 15, 30, 45, and 60% DDGS, respectively). Belly flop distance was lower for pigs fed Paylean ( $9.0$  vs.  $7.8 \pm 0.41$  cm). Increases in DDGS level were associated with increases in the unsaturated fat content and iodine value of belly and jowl fat (e.g., iodine value of jowl: 78.4 vs.  $93.4 \pm 1.35$  for 0 and 60% DDGS, respectively). Overall, these results suggest that at relatively low levels of DDGS (up to 15%), growth and carcass responses to Paylean are substantial and in line with expectations and that belly quality decreased as dietary DDGS inclusion increased.

**Key Words:** DDGS, Paylean, pigs

**210 In vitro evaluation of the fermentation characteristics in the pig intestines of hulless barleys differing in  $\beta$ -glucan content.** R. Jha<sup>1,2</sup>, J. Bindelle<sup>1,3</sup>, B. Rossnagel<sup>2</sup>, A. Van Kessel<sup>2</sup>, and P. Leterme\*<sup>1</sup>, <sup>1</sup>Prairie Swine Centre Inc., Saskatoon, SK, Canada, <sup>2</sup>University of Saskatchewan, Saskatoon, SK, Canada, <sup>3</sup>Faculté des Sciences agronomiques, Gembloux, Belgium.

Non-starch polysaccharides (NSP) in isolated form, especially  $\beta$ -glucans, are reported to have prebiotic effects in pigs. However, little information is available on the possible functional properties of these NSP when the latter are still present in the fibrous matrix of whole cereals. Hulless barleys (HB) are good sources of  $\beta$ -glucans and the content is quite variable among varieties. In order to evaluate the potential of HB as functional feeds, an in vitro experiment was carried out to study the fermentation characteristics of 6 HB varieties varying in their  $\beta$ -glucan contents (36-99 g/kg DM) in comparison to 3 hulled barleys and 5 oats. After a pepsin-pancreatin hydrolysis, the ingredients were incubated in a buffer solution containing minerals and pig feces as inoculum. The accumulated gas production, proportional to the amount of fiber fermented, was measured for 48 h and modeled. Short-chain fatty acid (SCFA) and ammonia concentration were measured in the fermented solutions. A cereal type effect ( $P < 0.05$ ) was observed on the fermentation kinetics parameters. Rates of degradation and total gas productions were higher in HB than in oats ( $P < 0.05$ ) but no difference was observed between HB varieties. On the contrary, differences were found between HB for lag time and rate of degradation. The production of SCFA was also higher with HB (6.1 mMol/g DM incubated;  $P < 0.05$ ) than with hulled barleys and oats (4.9 and 2.9 mMol/g DM incubated respectively). In contrast, oats generated higher ammonia ( $P < 0.05$ ) production (1.4 mMol/g DM incubated, on average) than barley (1.0 mMol/g). In conclusion, HB are better fermented in vitro, produce more beneficial (SCFA) and less harmful (ammonia) metabolites and have a better potential than other cereal species to modulate gut microbiota and improve gut health.

**Key Words:** NSP, pig, fermentation

**211 Effects of fat sources on growth performance, blood composition and fatty acid digestibility in weaning pigs.** J. H. Lee<sup>\*1</sup>, J. H. Cho<sup>1</sup>, Y. J. Chen<sup>1</sup>, J. D. Hancock<sup>2</sup>, J. H. Lee<sup>3</sup>, and I. H. Kim<sup>1</sup>, <sup>1</sup>Dankook University, Cheonan, Korea, <sup>2</sup>Kansas State University, Manhattan, <sup>3</sup>Jinju National University, Gyeongnam, Korea.

This study was conducted to evaluate the effects of fat sources on growth performance, blood composition and fatty acid digestibility in weaning pigs. One hundred twenty pigs (Landrace × Yorkshire × Duroc, 8.60 kg average initial body weight) were used in a 35 d growth assay. Dietary treatments were: 1) CON (soy oil 5.11% diet), 2) CO1.0 (soy oil 4.11%+coconut oil 1.0%), 3) LLA1.0 (soy oil 4.11%+lauric acid(46%) 1.0%), 4) HLA0.5 (soy oil 4.61%+lauric acid(99%) 0.5%), 5) HLA1.0 (soy oil 4.11%+lauric acid(99%) 1.0%) and 6) MFA1.0 (soy oil 4.11%+medium chain fatty acid(C8:0, C10:0 96%) 1.0%). The pigs were allotted into five pigs per pen with four replicate pens per treatment by completely randomized design. From d 0 to 35, ADG was greater in HLA1.0 and MFA1.0 treatments than CON treatment ( $p<0.05$ ). ADFI was greater in CO1.0 and MFA1.0 treatments than HLA0.5 treatment ( $p<0.05$ ). In week 2, digestibility of dry matter was higher in CO1.0, HLA1.0 and MFA1.0 treatments than CON treatment ( $p<0.05$ ). Nitrogen digestibility was increased in CO1.0, LLA1.0 and HLA1.0 treatments compared to CON treatment ( $p<0.05$ ). Energy digestibility was higher in CO1.0 treatment than CON treatment ( $p<0.05$ ). In week 5, CON showed the lowest digestibilities of dry matter, nitrogen and energy among treatments ( $p<0.05$ ). Saturated fatty acid digestibility was increased in CO1.0 treatment compared to other treatments ( $p<0.05$ ). Mono unsaturated fatty acid digestibility were increased in CO1.0 treatment compared to LLA1.0, HLA0.5 and MFA1.0 treatments ( $p<0.05$ ). CON and CO1.0 treatments showed the highest digestibility of n-6 fatty acid ( $p<0.05$ ). In blood sample at week 5, albumin concentration in CO1.0 and MFA1.0 treatments were improved compared to CON treatment ( $p<0.05$ ). IgG concentration in LLA1.0, HLA0.5 and MFA1.0 treatments were greater than CON treatment ( $p<0.05$ ). WBC concentration in MFA1.0 treatment was increased compared to CON treatment ( $p<0.05$ ). Therefore, it suggested that lauric acid and middle chain fatty acid supplementation could improve growth performance, nutrient digestibility, albumin, IgG and WBC concentration of weaning pigs.

**Key Words:** coconut oil, fatty acid digestibility, pigs

**212 Effects of American and Chinese DDGS on meat quality and amino acid content of pork.** H. D. Jang<sup>\*1</sup>, J. W. Hong<sup>2</sup>, J. H. Lee<sup>2</sup>, W. S. Lee<sup>2</sup>, C. Y. Lee<sup>3</sup>, I. B. Chung<sup>4</sup>, and I. H. Kim<sup>1</sup>, <sup>1</sup>Dankook University, Cheonan, Korea, <sup>2</sup>Institute of Animal Science, DAESANG Farmsco Co., Ltd, Korea, <sup>3</sup>Jinju National University, Korea, <sup>4</sup>National Institute of Animal Science, Korea.

This study was conducted to evaluate the effects of corn distiller's dried grains with solubles (DDGS) from American and Chinese sources on quality and amino acid content of pork. 120 crossbred pigs (64.50±1.70kg) were used in a 56 day growth assay (10 pens/treatment, 4 pigs/pen). Dietary treatments were: 1) CON (basal diet), 2) ADS (15% American DDGS), and 3) CDS (15% Chinese DDGS). *M. logissimus dorsi* was used to evaluate meat quality. Backfat thickness and lean percentage were not affected by treatment. Meat color (2.0, 2.3, 2.3) and redness (b\*) (16.91, 17.24, 18.41) were significantly increased in DDGS treatments compared to CON ( $P<0.05$ ). Water holding capacity (55.10 vs. 39.23 vs. 53.52 %) was higher in CON and CDS compared to ADS ( $P<0.05$ ). The pH of meat (5.53 vs. 5.61 vs. 5.71) was greater on DDGS than CON ( $P<0.05$ ). The content of amino acids in the meat were measured. CDS had a higher arginine (1.34 vs. 1.40 vs. 1.47 %), isoleucine (0.85 vs. 1.00 vs. 1.09 %), leucine (1.74 vs. 1.81 vs. 1.84 %)

and lysine (1.85 vs. 1.93 vs. 2.02 %) concentration compared to other treatments ( $P<0.05$ ), with intermediate values on DDGS. Methionine (0.57 vs. 0.60 vs. 0.61 %), phenylalanine (0.88 vs. 0.94 vs. 0.94 %), threonine (0.96 vs. 1.03 vs. 1.06 %) and valine (0.93 vs. 1.11 vs. 1.13 %) concentration were significantly improved by both DDGS treatments ( $P<0.05$ ). Cysteine (0.42 vs. 0.45 vs. 0.52 %) was greater on CDS than CON and ADS ( $P<0.001$ ). DDGS resulted in a higher cysteine concentration than CON ( $P<0.001$ ). Proline (1.63 vs. 1.45 vs. 1.42 %) was significantly improved by CON compared to CDS ( $P<0.05$ ). Tyrosine (0.77 vs. 0.83 vs. 0.84 %) was greater in pork from the two DDGS treatments than in pork from CON-fed pigs ( $P<0.01$ ). In conclusion, redness and amino acid concentration in meat were positively affected by DDGS from different countries.

**Key Words:** DDGS, meat quality, finishing pigs

**213 Validation of control diets for lactose and fish meal replacement studies in nursery pigs.** R. C. Sulabo<sup>\*</sup>, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 180 nursery pigs (PIC, 7.5 kg and 28 d of age) were blocked by BW and randomly allotted to 1 of 6 treatments: 1) corn-soybean meal based diet (NC), 2) NC + 10% food-grade whey, 3) NC + 10% feed-grade whey, 4) Diet 2 + 4.5% select menhaden fish meal (fish meal), 5) Diet 2 + 2.25% fish meal + 1.25% spray-dried blood cells, and 6) Diet 2 + synthetic amino acids. Each treatment had 5 pigs per pen and 6 replications. The 21 d trial started 7 d after weaning. From d 0 to 14, pigs fed the diet containing 10% feed-grade whey tended to have greater ADG ( $P<0.07$ ) and were heavier ( $P<0.08$ ) than pigs fed the NC diet, with pigs fed the diet containing 10% food-grade whey being intermediate. Pigs fed either food- or feed-grade whey to the NC diet tended to have better ( $P<0.06$ ) G:F compared with pigs fed the NC diet. Pigs fed phase 2 diets containing specialty protein sources tended to have greater ADG ( $P<0.07$ ) and heavier ( $P<0.07$ ) weights than pigs fed the diet containing 10% food-grade whey. Pigs fed the synthetic amino acids diet had similar ( $P>0.36$ ) ADG and body weight as pigs fed the diet containing the same food-grade whey but without specialty proteins. From d 0 to 21, only numerical differences ( $P>0.15$ ) were observed in performance between treatments. Our results indicate that the feed-grade whey and fish meal diets can serve as valid positive controls for lactose and fish meal replacement studies.

**Table 1. Effects of lactose and fish meal replacement control diets on growth performance of nursery pigs during Phase 2**

Item	Dietary treatment						SED
	Negative control	Food-grade whey	Feed-grade whey	SMFM + SDBC	SMFM	Synthetic amino acids	
d 0 to 14							
ADG, kg	0.35 <sup>a</sup>	0.37 <sup>ab</sup>	0.41 <sup>bc</sup>	0.43 <sup>c</sup>	0.43 <sup>c</sup>	0.37 <sup>ab</sup>	0.03
ADFI, kg	0.51	0.49	0.52	0.55	0.53	0.50	0.03
G:F	0.70 <sup>a</sup>	0.74 <sup>b</sup>	0.78 <sup>b</sup>	0.78 <sup>b</sup>	0.80 <sup>b</sup>	0.74 <sup>ab</sup>	0.02
Pig weight, kg							
d 0	7.5	7.5	7.5	7.5	7.5	7.5	0.005
d 7	9.4 <sup>a</sup>	9.5 <sup>ab</sup>	9.7 <sup>bc</sup>	9.8 <sup>bc</sup>	9.8 <sup>c</sup>	9.4 <sup>a</sup>	0.17
d 14	12.5 <sup>a</sup>	12.7 <sup>ab</sup>	13.2 <sup>bc</sup>	13.5 <sup>c</sup>	13.5 <sup>c</sup>	12.7 <sup>ab</sup>	0.39
d 21	16.6	16.6	17.4	17.4	17.5	16.6	0.51

**Key Words:** lactose, protein sources, nursery pigs

**214 Comparison between the total fecal collection and indigestible marker methods to determine the digestibility of canola meals in growing pigs.** C. A. Montoya\* and P. Leterme, *Prairie Swine Centre Inc., Saskatoon, SK, Canada.*

The total fecal collection is the reference method for digestibility determination in pigs but it is time-consuming and expensive. Indigestible markers allow for incomplete collection and shorter periods but their validity for the evaluation of by-products is often questioned. The aim of this study was to compare the total fecal collection method and the use of an indigestible marker to measure the nutrient digestibilities and digestible energy (DE) content of different canola meals (CM). A total of 60 growing pigs (30 ± 4 kg BW; 6/diet) were fed with two basal diets and eight CM-based diets (2/3 basal diet, 1/3 CM). The diets were supplemented with Celite as a source of acid-insoluble ash (AIA; 0.72 to 1.65 g AIA/kg diet). The pigs were kept in metabolic cages for 18 d (8 d adaptation period, 10 d total fecal collection). The results of digestibility (DM, N and energy) and the DE contents were tested for the 'method' effect. No difference was observed between the total amount of AIA ingested and excreted on average (92.1 vs 86.1 g; P = 0.1). The digestibility values were systematically lower with the AIA method, compared to the total fecal collection, for DM (80.1 vs 81.7%; P < 0.003), N (82.7 vs 83.9%; P < 0.003) and energy (79.8 vs 81.4%; P < 0.01). On the contrary, the overall results obtained for the different CM types were similar for both methods (78.0 vs 78.3% for DM, 83.2 vs 84.0% for N; 78.1 vs 78.5% for energy and 3.9 vs 3.9 Mcal/kg for the DE content, for the total fecal collection and marker methods, respectively). However, differences between methods were observed for some individual CM samples and were either higher (+ 13% for the DE content) or lower (-14%) with the marker. These differences and the variability had major effects on the estimation of the digestibilities and DE content of CM alone, calculated by difference. We conclude that, in the conditions of our study, AIA is not suitable for the estimation of the digestibility of CM in growing pigs.

**Key Words:** pig, digestibility, canola meal

**215 Amino acid and energy digestibility of high-protein corn distillers dried grains in pigs.** J. J. Jacela\*, H. L. Frobose, J. M. DeRouche, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

Dry defractionation is a process that optimizes the use of corn by separating the kernel into its bran, germ, and endosperm components before fermentation for ethanol fuel production. This yields a distillers grains product that is higher in CP but with lower fat content. A study was conducted to determine the digestibility of amino acids (AA) and energy content of a specialized high-protein corn distillers dried grains (HP-DDG) co-product. Six growing barrows (BW = 22.7 kg) were surgically fitted with T-cannulas at the terminal ileum and randomly allotted to 2 treatments in a crossover design with 2 periods. The first diet contained 67% HP-DDG as the sole protein source; the second was a N-free diet for determining basal endogenous AA loss. Chromic oxide was added to both diets as an inert marker. Digesta and fecal samples were collected and analyzed for AA and energy concentrations. After chemical analysis, standardized and apparent ileal digestible (SID and AID, respectively) AA as well as GE, DE, ME, and NE values for HP-DDG were calculated. The chemical composition of the HP-DDG on a DM basis was 40.8% CP, 5.4% EE, 22.9% ADF, 36.6% NDF, 0.04% Ca and 0.42% P. The GE, DE, ME, and NE values were 5,293; 3,703; 3,426; and 2,131 kcal/kg DM, respectively. The DM content was 89.5%. The HP-DDG had greater AA digestibility than previously reported

traditional DDGS. Therefore, this HP-DDG appears to be well-suited for use in swine diets.

**Table 1. Amino acid composition and digestibility, DM basis**

Amino acid	%	SID,%	AID,%
Arginine	1.84	85.3	83.8
Cysteine	0.85	76.8	75.5
Histidine	1.16	80.0	79.0
Isoleucine	1.69	81.4	80.2
Leucine	5.45	88.9	88.3
Lysine	1.36	67.8	65.9
Methionine	0.88	87.5	87.0
Phenylalanine	2.14	86.1	85.2
Threonine	1.45	75.0	72.8
Tryptophan	0.26	78.6	76.2
Valine	2.21	79.7	78.1

**Key Words:** swine, distillers dried grains, amino acids

**216 Effect of dam parity on growth performance and immune response of weaned pigs.** E. E. Carney\*, H. Tran, J. W. Bundy, R. Moreno, D. E. Reese, P. S. Miller, and T. E. Burkey, *University of Nebraska, Lincoln.*

The progeny of first parity (P1) dams may have reduced growth performance compared to progeny from mature dams (≥ P2). The objective of this experiment was to evaluate the effect of dam parity on growth performance and immune response in progeny derived from different parities. Weaned pigs (n = 96) derived from P1 or P4 dams were allotted to 2 dietary treatments: control (CTL) or antibiotic (Mecadox; AB), creating 4 treatments: 1) P1, CTL; 2) P1, AB; 3) P4, CTL; and 4) P4, AB. There were 4 pens per treatment and 6 pigs per pen and growth performance was monitored over 3 phases: Phase I (d 0 to 7); Phase II (d 8 to 21); and Phase III (d 22 to 42). Initial BW (6.3 vs. 5.7 ± 0.1 kg for P4 and P1 progeny, respectively) was used as a covariate and orthogonal contrasts were used to evaluate effect of parity, dietary treatment, and their interaction. To evaluate immune response, pigs (n = 4 per pen) were vaccinated against *M. hyopneumoniae* (Mh). Antibody titers to Mh were quantified via Tween 20 ELISA. No parity × dietary treatment interactions were observed in this experiment. Across both dietary treatments, P4 progeny had greater (P < 0.01) BW than P1 progeny at d 0, 7 (7.0 vs. 6.5 ± 0.1 kg), 21 (12.3 vs. 11.3 ± 0.2 kg), and 42 (26.3 vs. 24.3 ± 0.5 kg). On d 42, CTL pigs tended (P = 0.054) to have greater BW compared to AB pigs when averaged across parity. Across both dietary treatments, G:F in Phase I tended (P < 0.10) to be greater for P1 compared to P4 progeny; and ADFI, in both Phase II and III, was greater (P < 0.02) for P4 compared to P1 progeny (0.54 vs. 0.45 and 1.09 vs. 1.01 ± 0.02 kg respectively, for Phase II and III). During Phase III, AB pigs had decreased (P < 0.05) G:F compared to CTL pigs (0.60 vs. 0.63 ± 0.01). Overall (d 0 to 42), P4 progeny tended (P < 0.10) to have greater ADG and ADFI compared to P1 progeny and G:F tended (P < 0.10) to be decreased in P4 compared to P1 progeny. In addition, overall ADG and G:F for AB pigs tended (P < 0.10) to be decreased compared to CTL pigs. There were no effects of parity, dietary treatment, or their interaction on Mh titers. These results suggest that growth performance may be affected by dam parity.

**Key Words:** dam parity, growth, pigs

**217 Effects of two types of carbohydrase supplements on apparent ileal and total tract nutrient digestibility of American and Chinese distiller's dried grains with solubles (DDGS) in growing pigs.** J.H. Lee\*<sup>1</sup>, I.H. Kim<sup>1</sup>, J.S. Yoo<sup>1</sup>, J.W. Hong<sup>2</sup>, J.H. Lee<sup>2</sup>, W.S. Lee<sup>2</sup>, and S.D. Lee<sup>3</sup>, <sup>1</sup>*Department of Animal Resource & Science, Dankook University, Cheonan, Korea*, <sup>2</sup>*Institute of Animal Science, DAESANG Farmsco Co., Ltd, Korea*, <sup>3</sup>*National Institute of Animal Science, Korea*.

Two experiments were conducted to evaluate the effect of two types of carbohydrases on the AID of AA, DM, N, E (energy) and ATTD of DM, N and E of diets containing 20% DDGS in growing pigs. Four barrows (23.67kg) were surgically fitted with simple T-cannulas. The DDGS used in Exp. 1 and Exp. 2 were obtained from USA and China, respectively. Both experiments consisted of 4x4 Latin squares with pigs and periods being used as the blocking criteria. Experimental treatments were: 1) CON (corn-soybean diet); 2) DDGS (20% DDGS diet); 3) DC1 (DDGS + carbohydrase S 0.1%) and, 4) DC2 (DDGS + carbohydrase C 0.1%). In Exp. 1, the AID of DM, N and E was higher in the CON-fed pigs than those fed DDGS ( $p < 0.05$ ), while the ATTD of DM was higher on CON than on the DDGS treatment ( $p < 0.05$ ). The AID of amino acids, both essential and non-essential, were greatest in pigs fed CON ( $P < 0.01$ ). No effects were observed on the ATTD of nutrients in Exp. 1. In Exp. 2, the AID of DM, N, E, total AA, essential AA and non-essential AA was significantly lower on DDGS than on CON and on the carbohydrase supplemented treatments ( $p < 0.05$ ). Therefore, these results suggest that dietary supplementation of 20% DDGS decreased nutrient digestibility, whereas such negative effects may be amended by carbohydrase supplementation.

**Key Words:** DDGS, apparent ileal digestibility, growing pigs

**218 Evaluation of iron status and iron transfer efficiency in sows following dietary administration of  $\delta$ -aminolevulinic acid and vitamin C.** Y.J. Chen\*<sup>1</sup>, L. Yan<sup>1</sup>, D.K. Kang<sup>1</sup>, Y. Hyun<sup>2</sup>, and I.H. Kim<sup>1</sup>, <sup>1</sup>*Department of Animal Resource & Science, Dankook University, Cheonan, Korea*, <sup>2</sup>*Easy Bio System, Korea*.

This study was conducted to evaluate the impact of dietary administered  $\delta$ -aminolevulinic acid (ALA) and vitamin C on the hematological profiles and performance of sows and suckling pigs, as well as to determine if iron status could be improved via dietary administration of ALA. Seven days prior to parturition, 120 sows (Landrace x Yorkshire) were randomly assigned with parities of 1, 2 or 3+ to one of 4 dietary treatment groups. The treatments were arranged as a 2x2 factorial design containing two ALA levels (0 or 10 mg/kg) and two vitamin C levels (0 or 500 mg/kg). After following parturition, sows were allowed free access to a lactation diet that contained same levels of ALA and vitamin C as gestation diet. Sows provided diets with ALA tended to consume more feed ( $P < 0.10$ ) than sows fed diets that did not contain ALA (5.03 vs. 4.80 kg). Conversely, backfat losses were lower (-4.24 vs. -5.45 mm) in sows that received the ALA treatments when compared to those that received the non ALA supplemented diets ( $P < 0.05$ ). Combined supplementation with ALA and vitamin C resulted in improved hematological profiles (total protein, albumin and IgG) in sows ( $P < 0.05$ ). The iron status in the blood (111 vs. 86  $\mu\text{g/dL}$ ) and milk (1.96 vs. 1.21%) was also improved by ALA supplementation ( $P < 0.05$ ). Moreover, the BW at weaning and the ADG during the suckling period increased in response to co-administration of ALA and vitamin C ( $P < 0.05$ ). The iron status of piglets was also improved (140 vs. 118  $\mu\text{g/dL}$ ) by ALA supplementation ( $P < 0.05$ ). In conclusion, dietary supplementation of ALA can increase the iron status of sows and suckling pigs, as well as

the iron transfer efficiency from sows to piglets via elevated milk iron concentrations.

**Key Words:**  $\delta$ -aminolevulinic acid, iron status, sow

**219 The influence of complexed minerals fed to developing maternal gilts through three parities on reproductive and lactation performance.** C. L. Bradley\*<sup>1</sup>, J. W. Frank<sup>1</sup>, C. V. Maxwell<sup>1</sup>, Z. B. Johnson<sup>1</sup>, T. L. Ward<sup>2</sup>, and M. E. Wilson<sup>2</sup>, <sup>1</sup>*University of Arkansas, Fayetteville*, <sup>2</sup>*Zinpro Corporation, Eden Prairie, MN*.

In order to evaluate the long term effects of feeding complexed minerals to developing gilts on reproductive and lactation performance, immature gilts were used in a long term reproductive study. Gilts (GPK35) were delivered in group sizes of 20 to 32 gilts (initial BW =  $27.0 \pm 1.4$  kg; approximately 10 wk of age). Upon arrival to the farm, gilts were randomly assigned to one of two dietary treatments, a control diet supplemented with inorganic mineral sources (sulfates) and no chromium (CTL) or the control diet supplemented with Zinpro complexed minerals (ORG; Zn, Cu, Mn, and Cr). The gilts remained on the same dietary treatment throughout the study. Gilts were bred at  $174.3 \pm 1.7$  kg BW. Reproductive and farrowing performance parameters were recorded through the first three parities with a total of 391 litters represented (193 parity 1 litters, 120 parity 2 litters, and 78 parity 3 litters). There were no treatment differences for number of sows bred by d 7 post-weaning ( $P = 0.90$ ) or percent farrowed ( $P = 0.91$ ) for the 3 parities studied. There were no treatment differences for sow weight at breeding, 110 d gestation, or weaning, however sows fed ORG lost more BW during lactation than sows fed CTL (12.67 versus 9.36 kg,  $P = 0.07$ ). Interestingly sows fed ORG had heavier litters at birth compared to sows fed CTL (18.89 versus 18.07 kg,  $P = 0.10$ ), although number born alive was not different (13.37 versus 12.89 piglets,  $P = 0.20$ ). In addition, sows fed ORG weaned heavier litters than sows fed CTL (67.15 versus 63.73 kg,  $P = 0.08$ ), while number weaned was not different (10.74 versus 10.53 piglets,  $P = 0.33$ ). This response is likely attributable to the fact that sows fed ORG consumed more total feed during lactation than sows fed CTL (118.9 versus 111.9 kg,  $P = 0.04$ ). Our results indicate that sows fed Zinpro complexed minerals have improved litter birth weights and weaning weights, while consuming more feed during lactation.

**Key Words:** sow, mineral, lactation

**220 Influence of complexed minerals during gilt development on growth performance and claw wall growth.** C. L. Bradley\*<sup>1</sup>, J. W. Frank<sup>1</sup>, C. V. Maxwell<sup>1</sup>, Z. B. Johnson<sup>1</sup>, T. L. Ward<sup>2</sup>, and M. E. Wilson<sup>2</sup>, <sup>1</sup>*University of Arkansas, Fayetteville*, <sup>2</sup>*Zinpro Corporation, Eden Prairie, MN*.

A long-term gilt development study used 372 maternal line gilts (GPK35) to evaluate the effect of complexed minerals (Zn, Cu, Mn and Cr) on growth performance and claw wall growth. Upon arrival to the farm, gilts were randomly assigned to one of two dietary treatments, a control diet supplemented with inorganic mineral sources (sulfates) and no chromium or the control diet supplemented with complexed minerals (Zn, Cu, Mn and Cr from Zinpro). Gilts were delivered in group sizes ranging from 20 to 32 gilts (initial BW =  $27.0 \pm 1.4$  kg and approximately 10 wk of age). There were 4 developmental feeding phases: Phase 1 from 27.0 to 44.9 kg (1.25% Lys, 3526 kcal/kg ME); Phase 2 from 44.9 to 66.9 kg (0.89% Lys, 3287 kcal/kg ME); Phase 3 from 66.9 to 94.5 kg (0.75% Lys, 3472 kcal/kg ME); and Phase 4 from 94.5 to 112.2 kg (0.60% Lys, 3217 kcal/kg ME). Body weight, ADG,

ADFI, and G:F were recorded for each phase. Claw wall growth was evaluated by notching a groove into the front right outer and front left inner claw of each gilt and measuring the change in distance between the notch and the coronary band. From these measurements, overall claw growth and growth per day were calculated. Toe length was also measured. There were no differences between dietary treatments for BW, ADG, ADFI, G:F, toe length, overall claw growth, or growth of the claws per day ( $P \geq 0.08$ ). Phases 1 through 4 ADG were 0.69, 0.73, 0.84, and 0.68 kg/d respectively and ADFI were 1.49, 2.15, 2.73, and 2.92 kg/d respectively. Toe length of both claws ranged from 29.4 mm at the end of Phase 1 to 37.0 mm at the end of Phase 4. The claw wall grew on average of 0.47 mm per d during Phase 2, 0.45 mm per d during Phase 3, and 0.55 mm per d during Phase 4. In conclusion, mineral source did not impact growth performance or claw wall growth in developing maternal line gilts.

**Key Words:** gilt, mineral, claw

**221 Effects of carbadox on microbial ecology in ileal digesta and feces of weanling pigs.** M. Song<sup>\*1</sup>, L. L. Stewart<sup>1</sup>, J. Barnes<sup>1</sup>, J. A. Soares<sup>1</sup>, B. R. Gramm<sup>2</sup>, R. D. Nimmo<sup>2</sup>, H. H. Stein<sup>1</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL, USA, <sup>2</sup>Phibro Animal Health Co., Ridgefield Park, NJ, USA.

A study was conducted to evaluate effects of carbadox on microbial ecology in ileal digesta and feces of weanling pigs. Pigs ( $n = 15$ ,  $9.3 \pm 0.8$  kg BW) were surgically fitted with a T-cannula in the distal ileum and were assigned randomly to one of 3 dietary treatments. The treatments were: 1) a corn-soybean meal diet (CON), 2) CON + 27.5 ppm carbadox (LO), and 3) CON + 55 ppm carbadox (HI). During the 6-wk experiment, all pigs were fed CON during wks 1, 5, and 6 and their respective treatments during wks 2, 3, and 4. Ileal digesta and feces were collected on d 6 and 7 of each period to measure the number of bacterial cells by Gram's method and to assess bacterial populations by denaturing gradient gel electrophoresis (DGGE). Results from DGGE included the species diversity (the number of bands) and the similarity of population structures (Sorenson's pairwise similarity coefficients (Cs)) assessed across pigs within treatment (INTRA), between treatments (INTER), and between treatment period and subsequent period within pig (INTER-P). There were no carbadox effects on the number of bacterial cells or bands, and the INTER Cs values did not show clear carbadox effects. The ileal INTRA Cs values of the carbadox treatments were lower ( $P < 0.05$ ) than the controls in wk 2 (78, 75 & 93% for LO, HI & CON, respectively), but higher in wk 4 (89, 95 & 80%), suggesting that carbadox eventually makes pigs more uniform in microbiota after an initial disruption. The ileal INTER-P Cs values of the carbadox treatments were lower than the controls comparing the treatment period to wk 5 (68, 74 & 81%;  $P < 0.10$ ) and wk 6 (67, 73 & 84%;  $P < 0.05$ ), suggesting that ileal microbiota is changed by feeding carbadox. Several specific bands were present in most pigs fed CON, but absent from most pigs fed LO or HI in ileal digesta. Those patterns were not shown in feces. In conclusion, carbadox modifies ileal microbiota and makes it more uniform across pigs.

**Key Words:** carbadox, microbial ecology, weanling pigs

**222 Effect of carbadox on apparent ileal digestibility of amino acids by nursery pigs.** L. L. Stewart<sup>1</sup>, B. G. Kim<sup>\*1</sup>, B. R. Gramm<sup>2</sup>, R. D. Nimmo<sup>2</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL, <sup>2</sup>Phibro Animal Health Co., Ridgefield Park, NJ.

We investigated the effects of dietary carbadox on apparent ileal digestibility (AID) of AA by nursery pigs. Fifteen weanling barrows with a

mean BW of 9.6 kg (SD = 0.89) were surgically fitted with a T-cannula in the distal ileum. Animals were allocated to 3 dietary treatments with 5 pigs per treatment in a completely randomized design. Dietary treatments included: 1) a basal diet based on corn and soybean meal, 2) a basal diet plus 27.5 mg/kg carbadox, and 3) a basal diet plus 55 mg/kg carbadox. Ileal digesta were collected during 6 periods. Treatment diets were provided during period 2, 3, and 4; the basal diet was fed to all pigs during period 1, 6, and 7. Ileal samples were collected on d 6 and 7 of each period. In pigs fed the basal diet throughout the experiment, the AID of CP and many AA was greater by 3.0 to 9.3 percentage units during period 2, 3, and 4 than during period 1 ( $P < 0.05$ ). This indicates that the AID of CP and AA was affected by period during the first few wk of the experiment. Data were standardized by extracting the AID of period 1 from that of period 2, 3, and 4. The AID changes from period 1 to period 2, 3, and 4 for Ile (8.0 vs. 3.7%), Leu (6.6 vs. 2.9%), Met (7.5 vs. 3.1%), Phe (6.5 vs. 3.1%), Val (8.7 vs. 4.1%), Ala (10.7 vs. 5.5), and Asp (5.9 vs. 1.5%) were greater for pigs fed diets supplemented with 55 mg/kg carbadox during period 2, 3, and 4 than in pigs fed the basal diet ( $P < 0.05$ ). The AID for AA (Ile, Met, Ala, and Pro for 27.5 mg/kg carbadox; Ile, Met, Phe, Thr, Val, Ala, and Cys for 55 mg/kg carbadox) was less during period 5 and 6 compared with period 2, 3, and 4 in pigs fed diets supplemented with carbadox ( $P < 0.05$ ). This observation suggests that the positive effect of carbadox on AID of AA is lost after carbadox is removed from the diet. Overall, the inclusion of carbadox at 55 mg/kg in diets fed to weanling pigs increases the AID of AA.

**Key Words:** amino acids, carbadox, ileal digestibility

**223 Comparison of a yeast-derived protein source (NuPro<sup>®</sup>) and plasma protein in pig starter diets: wean-to-finish performance response.** P. Groenewegen<sup>\*1</sup>, J. Lampe<sup>2</sup>, and G. Gourley<sup>2</sup>, <sup>1</sup>Alltech Inc., Nicholasville, KY, USA, <sup>2</sup>Swine Graphics Enterprises, Webster City, IA, USA.

The objective of this experiment was comparison of wean-to-finish performance of pigs given starter diets containing either plasma protein or a yeast-derived protein source (NuPro<sup>®</sup>, Alltech Inc.) offered in two feeding regimes. A total of 640 mixed sex, high health piglets weaned at 17-20 d were randomly allotted to 32 pens of 20 pigs and split-sex fed by 4 treatments (8 pens/trt) in a 4-phase program. Treatments were 1) a negative control (no plasma or NuPro), 2) positive control (5% plasma protein in phase 1 and 2.5% in phase 2), 3) NuPro included at 4.13, 2.75 and 2% in phases 1, 2 and 3, respectively and fed to approximately 15 kg BW, or 4) NuPro included at 4.13, 2.75, 0.75 and 0.75% in phase 1-4, respectively and fed to approximately 25 kg BW). NuPro was formulated into diets at the expense of plasma protein in phases 1 and 2, and at the expense of soybean meal in phases 3 and 4. Regardless of treatment, the feeding plan consisted of 1.4, 2.27, 6.4 and 12.7 kg/pig of phase 1-4 diets, respectively. Pen weights were taken on d 0, 7, 14, 21, 28, 35, 47, 78, 106, 140 and 167. Individual weights were obtained on d 0, 47 and 167 for calculation of coefficients of variation (CV). Pen weights were experimental units for performance measurements. Daily gains d 0-167 (740, 735, 726, 749 g/d for trts 1-4, respectively,  $P=0.51$ ) and FCR (2.56, 2.57, 2.55, 2.54 for trts 1-4, respectively,  $P=0.74$ ) were similar among treatments. CV values of the NuPro treatments were statistically similar and were reduced compared to the negative control ( $P < 0.05$ ) and numerically lower than the positive control (12.61, 11.07, 9.20, 9.64 for trts 1-4, respectively). These results indicate that NuPro can be formulated in piglet diets in place of plasma in Phases 1 and 2 and replace a portion of other protein sources in Phases 3 and 4, without diminishing performance.

**Key Words:** weanlings, yeast, plasma protein

**224 Dietary anionic mineral (CAD-MATE®) addition increases body pools of readily exchangeable Ca in prepartum sows.** C. Darriet<sup>\*1</sup>, D. E. Axe<sup>2</sup>, and T. D. Crenshaw<sup>1</sup>, <sup>1</sup>University of Wisconsin, Madison, <sup>2</sup>Granco Minerals, Petersburg, VA.

Increased milk production by “elite” sows is associated with an increase in unexplained sow mortality during the prepartum and early postpartum periods. This association has led to purported claims of hypocalcemic disorders. Assuming responses similar to dairy cows, feeding anionic mineral salts in late gestation and early lactation periods might help reduce potential hypocalcemia related disorders in sows. CAD-MATE (Granco Minerals, Petersburg, VA), a novel anionic mineral supplement, was fed to 30 multiparous gestating sows (Landrace x Large White) to determine the dose required to increase Ca pools. CAD-MATE was added to a standard gestation diet at 0, 0.5, 1.0, 1.5, 2.0 or 2.5% which provided 33, -17, -67, -116, -166, and -216 mEq excess cations (Na+K-Cl-S). Animals were fed 1 of 6 diets for 12 d. Composites from 24-h urine samples collected via bladder catheters over the last 2 days were analyzed to identify renal compensatory responses to acid loads. Urine pH decreased with incremental additions of CAD-MATE, but increases in urinary Ca excretion were only observed at 2.0 and 2.5% CAD-MATE additions. As expected, urine Cl and SO<sub>4</sub> excretion increased with incremental additions of CAD-MATE. Venous blood (2 sows/trt) pH (range 7.41-7.33) and base excess (range 5.4-0.5 mmol/L) decreased linearly (P<0.10) but ionized Ca (range 1.28-1.37) increased linearly (P<0.05) as dietary CAD-MATE increased. Blood anion gap was not affected (P>0.10). In conclusion, CAD-MATE induced an acid load as exhibited by urinary ion excretion patterns, but dietary acid loads were compensated as reflected by maintenance of blood gas values within physiological ranges. At 2.0 and 2.5% inclusion, compensatory responses to CAD-MATE apparently induced Ca regulatory mechanisms, inferring that at least 2.0% CAD-MATE addition is required to increase mobilization of body Ca pools in prepartum sows.

**Table 1. Dietary CAD-MATE, %**

Urine	0	0.5	1.0	1.5	2.0	2.5	SEM
pH <sup>a</sup>	7.47	6.23	5.61	6.08	5.74	5.52	0.3
Ca, mEq/d <sup>ab</sup>	38.3	39.9	32.3	46.3	66.1	67.6	6.0
Cl, mEq/d <sup>ac</sup>	196	183	230	290	360	300	30.0
SO <sub>4</sub> , mEq/d <sup>a</sup>	171	192	239	314	316	443	39.9

<sup>a</sup>linear, <sup>b</sup>quadratic, <sup>c</sup>cubic response to CAD-MATE, P<0.05

**Key Words:** swine, dietary cation-anion balance, hypocalcemia

**225 Effect of an enzyme blend (Livestock Answer®) on growth performance of nursery pigs.** J. M. Benz<sup>\*</sup>, J. L. Nelssen, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, and S. S. Dritz, Kansas State University, Manhattan.

A total of 180 pigs (PIC, 5.56 kg) were used in a 28-d trial to determine the influence of an enzyme blend (Livestock Answer®; contains amylases, cellulases, proteases, lipases, and phytases) on growth performance of nursery pigs. Pigs were blocked by BW and allotted to 1 of 3 levels of enzyme (0, 0.125, and 0.175%) at weaning. There were 10 replications with 6 pigs per pen. Diets were fed in two phases. Phase 1 (d 0 to 14) diets (1.35% SID Lys, 0.80% Ca, and 0.48% available P) were corn-soybean meal-based with 15% whey, 3% fishmeal, and 15% dried distillers grains with soluble (DDGS). Phase 2 (d 14 to 28) diets (1.30% SID Lys, 0.79% Ca, and 0.41% available P) were corn-soybean meal-based with 25% DDGS. Feed-grade antibiotics were not used in either phase. From d 0 to 14, increasing level of enzyme improved ADG (quadratic, P=0.04) and G:F (linear, P=0.05), and tended to improve

ADFI (quadratic, P=0.06) and d 14 BW (quadratic P=0.07). From d 14 to 28, enzyme level had no effect (P>0.20) on ADG or ADFI but reduced G:F (quadratic, P=0.04). Overall (d 0-28), the enzyme had no effect (P>0.22) on ADG, ADFI, G:F, or d 28 BW. However, the tendencies for improved BW at d 14 were maintained numerically at d 28. Feeding this enzyme blend improved ADG and G:F from d 0 to 14, with a level of 0.125% resulting in the best performance.

**Table 1.**

Item	Enzyme level				P	
	0%	0.125%	0.175%	SE	Linear	Quadratic
D 0 to 14						
ADG, g	181	225	204	10.0	0.04	0.04
G:F	0.79	0.84	0.84	0.02	0.05	0.47
D 14 to 28						
ADG, g	357	350	363	12.7	0.81	0.43
G:F	0.66	0.63	0.65	0.02	0.17	0.04
D 0 to 28						
ADG, g	269	288	284	10.1	0.23	0.53
G:F	0.70	0.69	0.70	0.01	0.50	0.35
D 14 BW	8.09	8.72	8.42	0.28	0.07	0.07
D 28 BW	13.1	13.6	13.5	0.41	0.23	0.50

**Key Words:** enzyme, growth, nursery pig

**226 Effect of intake of yeast β-glucans during lactation on post weaning performance of piglets after a pathogenic E. Coli infection.** P. J. L. Ramaekers<sup>\*1</sup>, C. H. M. Smits<sup>1</sup>, and J. J. Eissen<sup>2</sup>, <sup>1</sup>Swine Research Centre, Boxmeer, The Netherlands, <sup>2</sup>Trouw Nutrition International, Tilburg, The Netherlands.

In total one hundred ninety two piglets were used in two batches to examine the effect of intake of yeast β-glucans (Fibosel®) during lactation on post weaning performance after a pathogenic E. Coli infection. In the lactation period of 21 days, 4 female piglets per litter were allotted to one of two treatments at an age of 7 days (2.9 kg). Within each litter, 2 piglets received treatment 1 and the 2 other piglets received treatment 2. In treatment 1, the piglets were daily orally supplied with 2 ml yoghurt from day 7 till weaning. In treatment 2, the 2 ml yoghurt was supplemented with 4 mg yeast β-glucans (ca 200 ppm feed equivalents). After weaning, the piglets received 3 ml Colisol and were housed in groups of three piglets for seven days to acclimatise to their new environment and had free access to water and a commercial feed. Seven days after weaning, the piglets were housed individually, in the same room and with the same feed and feeders and then the piglets were orally infected with pathogenic E. Coli O149K91K88ac (109 cfu/ml). Post weaning diarrhoea was scored daily on a scale of 0, no diarrhoea till 3, watery faeces. Post weaning skin quality was scored daily on a scale of 0, pink (normal) till 4, grey. Body weight at weaning was similar among treatments. The piglets in the yeast β-glucans treatment had a higher (p<0.05) body weight at day 14 post weaning, had a higher (p<0.05) feed intake on day 5 and feed intake tended to be higher (p<0.1) on day 1 compared to the control treatment (Table 1). Diarrhoea score between day 14 till day 21 and overall skin scores tended to be lower (p<0.1) in the piglets in the yeast β-glucans treatment compared to the control treatment (Table 1). Results indicate that piglets tend to suffer less from an E-Coli infection when yeast β-glucans were fed. It is concluded that oral intake of yeast β-glucans of piglets during lactation has a positive effect on post weaning performance and general health of piglets under an E.Coli challenge.

**Table 1. Results body weight, feed intake, diarrhoea score and skin score**

		Control		Yeast $\beta$ -glucans		p value	
		Mean	stderr	Mean	stderr		
Body weight day 14	kg	8.0	0.1	8.4	0.1	0.04	
Feed intake day 1	g/d	271	10	289	10	0.10	
Feed intake day 5	g/d	160	13	195	13	0.05	
		Mean	std	Mean	std	Chi <sup>2</sup>	p value
Diarrhoea score d14-21	%	27.7	22.6	21.5	22.3	3.34	0.07
Skin score d 1 - 21	%	9.6	12.1	7.2	12.2	3.49	0.06

**Key Words:** piglets, E-Coli,  $\beta$ -glucans

**227 Effects of copper sulfate, zinc oxide, and NeoTerramycin on weanling pig growth and bacterial sensitivity.** N.W. Shelton\*, M. E. Jacob, M. D. Tokach, J. L. Nelssen, R. D. Goodband, S. S. Dritz, J. M. DeRouchey, R. Amachawadi, X. Shi, and T. G. Nagaraja, *Kansas State University, Manhattan.*

A total of 180 21-d old weanling pigs (5.03 kg BW) were used in a 42-d trial to determine the effects of NeoTerramycin or pharmacological levels of copper and zinc on weanling pig performance and bacterial susceptibility. There were five dietary treatments with six pens per treatments and five pigs per pen. Treatments were arranged in a 2 x 2 factorial with two levels of copper sulfate (0 or 125 ppm) and two levels of zinc oxide (0 or 3,000 ppm for 14 d and 0 or 2,000 for 28 d). The fifth treatment was NeoTerramycin (55 ppm neomycin sulfate +55 ppm Oxytetracycline HCl). All diets contained 165 ppm Zn and 16.5 ppm Cu from the trace mineral premix. Fecal samples were collected from 3 pigs per pen on d 42 to determine total coliform and *Escherichia coli* counts. Added Zn increased ( $P<0.04$ ) ADG from d 0 to 14 and ADFI from d 0 to 42. Added copper increased ( $P<0.05$ ) G:F from d 14 to 42. NeoTerramycin did not influence ( $P>0.07$ ) ADG or G:F. Copper and zinc treatments had no effect ( $P>0.07$ ) on total coliform or *E. coli* concentrations. When copper alone was in the diet, fecal *E. coli* were more susceptible (Cu X Zn interaction;  $P<0.05$ ) to neomycin and chlortetracycline. Added zinc increased ( $P<0.02$ ) *E. coli* resistance to neomycin and chlortetracycline. High levels of zinc improved performance in the early post weaning period while copper improved performance in the later phase. Copper and zinc influenced antibacterial susceptibilities of fecal *E. coli*.

	Control	High Cu	High Zn	High Cu & Zn	Neo Terramycin	SE
d 0-14						
ADG, g	169	184	218	210	180	18.7
G:F	0.90	0.85	0.98	0.90	0.92	0.03
d 14-42						
ADG, g	547	591	577	574	562	17.9
G:F	0.69	0.71	0.67	0.68	0.68	0.01
d 0-42						
ADG, g	418	454	456	450	432	15.3
G:F	0.71	0.72	0.70	0.70	0.70	0.01
Resistant <i>E. coli</i> on d 42, %						
Neomycin	78	25	67	83	81	11.2
Tiamulin	90	100	94	100	100	3.7
Oxytetracycline	94	72	86	89	94	8.4
Chlortetracycline	83	47	81	89	81	9.6

**Key Words:** copper, zinc, bacterial sensitivity

**228 In vitro assay to evaluate ability of enzymatically hydrolyzed yeast containing MOS to bind enteropathogenic bacteria.** S Jalukar\*, J. Oppy, and M. Holt, *Varied Industries Corporation, Mason City, IA, USA.*

This study evaluated the ability of enzymatically hydrolyzed yeast and yeast culture, manufactured as a combined supplement called Celmanax®, to bind enteropathogenic bacteria. Celmanax® contains complex sugars like galactosamine, mannose and mannan oligosaccharide (MOS). It is known that MOS or mannose plays an important role in preventing infections by some pathogenic bacteria by agglutinating them and preventing them from binding to the host tissue. The agglutinating ability of Celmanax® was determined using both a qualitative assay and a quantitative assay. For the qualitative slide agglutination experiment, Celmanax® 40, and 20 mg/mL was tested. 75  $\mu$ L of *E. coli* F 18 and different *Salmonella* species in log phase ( $10^{10}$ cfu/mL) and 75  $\mu$ L of Celmanax® were added to slides and swirled for 30 sec. Negative control had 75  $\mu$ L each of bacteria, and saline. Celmanax® control had 75  $\mu$ L each of Celmanax® 40mg/mL, and saline. Agglutination was observed and photographed. To enumerate the un-agglutinated *E. coli* and *Salmonella sp* cells in the presence of Celmanax®, 1.0 mL of overnight grown cell culture was centrifuged and pellet was resuspended in either sterile saline (control) or in 20 or 40 mg/mL Celmanax®. The tubes were left undisturbed for 30 min to allow agglutinated cells to settle. Un-agglutinated cells from the supernatant were enumerated by plating on Tryptic Soy Agar plates. The quantitative assay was done in quadruplet and standard deviation was calculated for the data analysis.

Clumps of agglutinated cells were seen in the slide agglutination test in a dose dependent manner when *E. coli* and *Salmonella* cells were mixed with Celmanax®. No agglutination was seen in the control. In the quantitative assay Celmanax® at both concentrations tested showed agglutination, with 40 mg/mL agglutinating 80-98% of the different *Salmonella spp.* cells and 53% of *E. coli* F 18 compared to the control. This research confirms what other researchers have demonstrated in the past that MOS containing products like enzymatically hydrolyzed yeast has a strong ability to bind certain enteropathogenic bacteria.

**Key Words:** MOS, bacteria

**229 Dose-dependent TNF- $\alpha$  production of porcine alveolar macrophages in response to yeast components.** M. T. Che\*<sup>1</sup>, R. W. Johnson<sup>1</sup>, K. W. Kelley<sup>1</sup>, K. A. Dawson<sup>2</sup>, C. A. Moran<sup>2</sup>, and J. E. Pettigrew<sup>1</sup>, <sup>1</sup> *University of Illinois, Urbana,* <sup>2</sup> *Alltech North American Bioscience Center, Nicholasville, KY.*

The study, consisting of 3 in vitro assays, was conducted to evaluate immuno-stimulatory effects of yeast components on porcine alveolar macrophages (AM $\Phi$ ) by measurement of TNF- $\alpha$  as an indicator. Three irradiated components of *Saccharomyces cerevisiae* cell wall, mannan oligosaccharide (MOS, Bio-Mos®),  $\beta$ -glucan, and mannan rich fraction (MRF) (0-3 mg/mL) and lipopolysaccharide (LPS, 0-10  $\mu$ g/mL) were tested. In assay 1, AM $\Phi$  collected from donor pigs (n=4) were stimulated with 7 treatment doses of MOS,  $\beta$ -glucan, MRF, or LPS. In assay 2, AM $\Phi$  from donor pigs (n=6) were stimulated with LPS in the presence of increasing levels (0-60  $\mu$ g/mL) of polymyxin B (PMB)-an anti-inflammatory substance. In assay 3, AM $\Phi$  from donor pigs (n=4) were stimulated with MOS,  $\beta$ -glucan, or MRF in the presence of PMB (30  $\mu$ g/mL). AM $\Phi$  were cultured for 24 h, washed 3 times, and then stimulated for 24 h prior to collection of supernatants for measurement of TNF- $\alpha$  by ELISA. In assay 1, TNF- $\alpha$  production of AM $\Phi$  activated by MOS (458 pg/mL) or  $\beta$ -glucan (376 pg/mL) was highest at the level of 0.5 mg/mL ( $P<0.01$ ) and the response pattern of AM $\Phi$  to  $\beta$ -glucan was

the same as that to MOS. When activated with MRF, AM $\Phi$  produced much less TNF- $\alpha$  if compared to AM $\Phi$  stimulated with MOS,  $\beta$ -glucan, or LPS. The TNF- $\alpha$  response to stimulation of MRF (164 pg/mL) and LPS (521 pg/mL) peaked at 2.5 mg/mL and 1  $\mu$ g/mL, respectively ( $P < 0.05$ ). In assay 2, the level of  $\geq 20$   $\mu$ g/mL of PMB significantly inhibited LPS-induced TNF- $\alpha$ . In assay 3, TNF- $\alpha$  production of AM $\Phi$  induced by  $\beta$ -glucan or LPS was substantially inhibited by PMB treatment ( $P < 0.01$ ). In contrast, MOS-induced TNF- $\alpha$  in the presence of PMB was reduced by only 4.2%. In general, the TNF- $\alpha$  response of AM $\Phi$  to stimulation by yeast components is dose-dependent. MOS and  $\beta$ -glucan, but not probably MRF, are potential immuno-stimulants and they appear to activate AM $\Phi$  by different mechanisms.

**Key Words:** porcine alveolar macrophages, TNF- $\alpha$ , yeast components

**230 Effects of phenyllactic acid on growth performance, nutrient digestibility, microbial shedding, and blood characteristics in pigs.** J. P. Wang<sup>\*1</sup>, H. J. Kim<sup>1</sup>, I. B. Chung<sup>2</sup>, J. H. Lee<sup>1</sup>, R. Nobel<sup>3</sup>, I. H. Kim<sup>1</sup>, and S. H. Oh<sup>3</sup>, <sup>1</sup>Dankook University, Cheonan, Choongnam, Korea, <sup>2</sup>National Institute of Animal Science, Korea, <sup>3</sup>North Carolina A&T State University.

Two experiments on weanling (Exp. 1, 6.27 $\pm$ 0.73 kg, n=90) and growing pigs (Exp. 2, 21.73 $\pm$ 1.29 kg, n=96, 56 d of age) were conducted to evaluate the effect of phenyllactic acid (PLA). In Exp. 1, treatments were: 1) CON, basal diet, 2) PC, CON + antibiotics, and 3) PLA, CON + PLA 0.5%. ADFI in pigs fed PC (739 g) and PLA (750 g) diets were increased ( $P < 0.05$ ) compared to CON (707 g) during the overall phase. PC and PLA tended to have a higher ADG and G:F from d 7 to 21 ( $P < 0.10$ ). The digestibility of DM was highest on PLA on d 21, and N digestibility was higher in both PC and PLA treatment ( $P < 0.05$ ) on d 21 and 42. The white blood cell (WBC) and lymphocyte levels were significantly improved by the inclusion of antibiotics or PLA in the diet. In Exp. 2, the four dietary treatments were included: 1) CON, basal diet, 2) PLA0.1, CON + 0.1% PLA, 3) PLA0.2, CON + 0.2% PLA, and 4) PLA0.3, diet 1 + 0.3% PLA. G:F tended to increase when PLA was added ( $P = 0.065$ ). The digestibility for DM did not differ among treatments, while there was a tendency ( $P < 0.10$ ) for N digestibility to improve as the PLA levels increased with the highest value on PLA0.2 (quadratic effect,  $P < 0.10$ ). The lymphocyte concentration linearly increased (60.60, 61.45, 64.90, 65.15%) with increasing levels of PLA on d 42 ( $P = 0.009$ ). The WBC tended to increase as the PLA levels increased ( $P = 0.085$ ). In both experiments, there was no effect of treatment on fecal pH or the presence of lactic acid bacteria, but the concentration of *E. coli* in feces decreased in response to the addition of PLA (linear effect,  $P < 0.001$ ). In conclusion, adding PLA to the diet can result in the same growth performance with antibiotics of nursery pigs and may have a potential to stimulate immune system for both weanling and growing pigs; thus it may have merits as a replacement for antibiotics in pigs.

**Key Words:** phenyllactic acid, microbial shedding, pigs

**231 Effects of probiotic supplementation on growth performance, blood immune-related cell population, meat quality and fecal ammonia gas emissions in finishing pigs.** S. O. Shin<sup>\*1</sup>, R. Noble<sup>2</sup>, H. D. Jang<sup>1</sup>, T. X. Zhou<sup>1</sup>, I. H. Kim<sup>1</sup>, and S. H. Oh<sup>2</sup>, <sup>1</sup>Dankook University, Cheonan, Korea, <sup>2</sup>North Carolina A&T State University.

A total of 80 pigs (65.42 $\pm$ 1.16 kg) were used in a 10 week feeding trial to evaluate the effects of dietary complex probiotic supplementation

on growth performance, immune-related cell population, meat quality, and fecal ammonia emissions in finishing pigs. Dietary treatments were: 1) NC (antibiotic-free diet), 2) PC (NC + 44ppm tylosin), 3) NCP (NC + 0.2% probiotics), and 4) PCP (NC diet + 22ppm tylosin + 0.1% probiotics). Each treatment had five replicate pens with four pigs per pen. Growth performance was not affected by treatment, while DM digestibility was higher ( $P < 0.05$ ) in PCP (78.66%) than other groups (74.62, 75.59, 74.29%, respectively). Both PC and PCP (80.87, 79.18%, respectively) had higher N digestibility ( $P < 0.05$ ) than NCP (74.71%). The yellowness (b\*) value of *M. logissimus dorsi* color was significantly increased ( $P < 0.05$ ) in NCP compared to PC. Also, the pH of *M. logissimus dorsi* was significantly highest ( $P < 0.05$ ) in the NC group. Total MUFA and total UFA in intramuscular fat were significantly higher ( $P < 0.05$ ) in NCP (35.11, 55.23%, respectively) than PC treatment (26.58, 48.55%, respectively). In fatty acid composition of back fat in *M. logissimus dorsi*, total SFA were significantly increased ( $P < 0.05$ ) by NCP (53.38%) compared with NC and PCP treatments (39.62, 42.35%, respectively), while PC (49.37%) had higher ( $P < 0.05$ ) total SFA than NC (39.62%). UFA:SFA ratio was significantly higher ( $P < 0.05$ ) in NC (1.43) than PC and NCP treatments (0.97, 0.93, respectively), in addition, PCP (1.29) had higher ( $P < 0.05$ ) UFA:SFA ratio than NCP (0.93). Feces and urine (150g : 150g) were collected stored and fermented for 5 d to determine the odor emission. NH<sub>3</sub> emission was significantly decreased ( $P < 0.05$ ) in NCP and PCP treatments (difference -78.33, -98.33 ppm, respectively) compared with NC and PC treatments (difference 165.00, 216.67 ppm, respectively). The results of the experiment indicated that dietary probiotics had positive effects on nutrient digestibility, meat quality and fecal odor emission gases in finishing pigs.

**Key Words:** probiotics, growth performance, finishing pigs

**232 Evaluation of a commercial enzyme on growing pig performance.** J.J. Jacela<sup>\*1</sup>, S.S. Dritz<sup>1</sup>, M.D. Tokach<sup>1</sup>, J.M. DeRouchey<sup>1</sup>, R.D. Goodband<sup>1</sup>, J.L. Nelssen<sup>1</sup>, and P. Brown<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, KS, <sup>2</sup>Agri-King Inc., Fulton, IL.

A total of 1,129 pigs (BW=34.4 kg) were used in a 56-d study to evaluate the effect of a commercial enzyme on growth performance and its energy replacement value in swine diets. Pigs were blocked based on initial BW and allotted to 1 of 6 dietary treatments in a 2 $\times$ 3 factorial arrangement. Dietary treatments had increasing levels of fat (0, 2.5, and 5.0%) without or with added enzyme (0.05% Agri-king REAP<sup>®</sup>). The product used was a proprietary blend of enzymes that has  $\beta$ -glucanase, cellulase, and protease activity. Phase 1 was fed from 34 to 50 kg BW, Phase 2 from 50 to 73 kg BW, and Phase 3 from 73 to 91 kg BW. Diets were corn-soybean meal-based with 15% dried distillers grains with solubles (DDGS) and balanced to a constant lys:calorie ratio (2.98, 2.68, and 2.38 g/Mcal ME for phases 1, 2, and 3; respectively) within diet phase. Overall (d 0 to 56), there were no interactions ( $P > 0.33$ ) between the addition of enzyme and added fat for ADG, ADFI, or G:F. There was no difference ( $P > 0.54$ ) in ADG, ADFI, or G:F between pigs fed diets with and without added enzyme. However, pigs fed diets with increasing added fat had improved (linear;  $P < 0.01$ ) ADG and G:F. For every 1% added fat, G:F was improved by 1.3 and 1.2% in pigs fed with 2.5 and 5.0% added fat in their diets, respectively. In conclusion, the addition of the commercial enzyme did not impact growth performance of pigs in this study but ADG and G:F improved with the addition of fat in the corn-soybean meal-based diets with 15% DDGS.

**Table 1. Effect of Enzyme at Increasing Levels of Fat on Growth Performance**

Item	Fat						Enzyme × Fat	Probability, P<		
	No Enzyme			Enzyme				Fat	Linear	Quadratic
	0	2.5	5.0	0	2.5	5.0				
BW, kg										
D 0	34.4	34.3	34.3	34.3	34.5	33.8	0.93	0.69	0.81	
D 56	86.8	87.9	87.4	86.6	87.2	87.6	0.94	0.47	0.62	
D 0 to 56										
ADG, kg	0.933	.951	0.946	0.927	0.941	0.960	0.33	0.01	0.54	
ADFI, kg	2.30	2.24	2.17	2.26	2.24	2.21	0.58	0.01	0.84	
G:F	0.41	0.43	0.44	0.41	0.42	0.44	0.69	<0.0001	0.96	

**Key Words:** pig, enzyme, growth

## Odor and Nutrient Management

**233 Nutrient balance and recoverable nitrogen and phosphorus of a commercial feedlot.** S. Q. Jones\*, J. M. DeRouchey, and J. M. Ham, *Kansas State University, Manhattan.*

The ability to develop a nutrient balance for livestock operations is important for maintaining a long-term sustainable production system with current and future environmental regulations. The objectives of this experiment were to determine the nutrient balance of a commercial feedlot and to determine the amount of recoverable nitrogen and phosphorus from the feedlot pen surface. A commercial feedlot with a capacity of approximately 35,000 in south central Kansas was used for this experiment from November 2005 to May 2006. The average number of head and body weight per pen were 66 and 434.5 kg, respectively. Each pen had a total area of 1,920 m<sup>2</sup>, which calculated to an average square meter of 29.1 per head. Intake of N and P was calculated based on daily feed delivery per pen as well as the analyzed nutrient level of the diet. Excretion of N and P was determined by subtraction of retained nutrients from intake nutrients. The nitrogen intake for cattle in the experiment was calculated to be 210.7 g/hd/d (SD = 29.8). Based on the assumed nitrogen retention of 28 g/hd/d, 13.3% of the nitrogen fed was retained by the animal. In addition, it was calculated that 135.6 g/hd/d (SD = 26.6) of nitrogen was lost or non-recovered, which represents 74.2% of the amount of nitrogen that was excreted. The phosphorus intake for cattle in the experiment was calculated to be 33.0 g/hd/d (SD = 4.3). Based on the assumed phosphorus retention of 6.5 g/hd/d, 19.7% of the phosphorus fed was retained by the animal. Also, it was calculated that 8.8 g/hd/d (SD = 4.7) of phosphorus was lost or non-recovered, which represents 33.3% of the amount of phosphorus that was excreted. In summary, significant amounts of nutrient excretion relative to nutrient intake levels occur in feedlot cattle. This coupled with subsequent losses of excreted nutrients from the pen surface, particularly nitrogen, needs to be further addressed to capture more nutrients in manure for increased value.

**Key Words:** environment, feedlot, nutrients

**234 On-farm evaluation of a combination of treatments to reduce gaseous emissions from swine facilities.** A. Rojo\*, B. A. Peterson, M. Ellis, T. Funk, Y. Zhang, S. Jerez, Y. Su, and M. Robert, *University of Illinois, Urbana.*

This study evaluated the combined effect of three treatments aimed at reducing gaseous emissions from swine facilities. It was carried out in a commercial wean-to-finish barn (1100 head capacity) as a CRD with two treatments: 1) Control (no treatment applied in the barn) and 2) Combined treatment. There were two replicates (barns) per treatment. The combined treatment had 3 components, namely, treatment of the stored manure with a neutralizing agent to increase the pH of the slurry, covering the surface of the manure in the pit with a liquid oil lid, and spraying the building air space with an atomized oil-based liquid acidifier. The barns had totally slatted floors with deep pits and tunnel and pit ventilation. The study was carried out over a 12-month period over 2 wean-to-finish cycles. Gas levels (ammonia, hydrogen sulfide, and carbon dioxide) and ventilation rates were continuously measured at the air inlet into the barn, two of the room exhaust fans, and one of the pit fans. Samples of exhaust air were taken every two weeks during a 3 month period to measure odor levels (using olfactometry). A subsample of 10% of the pigs (832 pigs/barn/2 cycles) was weighed at the beginning and end of each cycle. Total emission rates for ammonia were not different (P = 0.34) between treated and untreated barns (440 and 520 g/day, respectively; SEM = 33.7). Total emission rates for hydrogen sulfide were higher (P = 0.03) for the treated barns compared to the control (81.8 and 63.2 g/day, respectively; SEM = 0.54). Average odor concentrations tended to be lower (P = 0.07) for the treated barns (1,463 and 2,198 threshold units, respectively; SEM = 331.1). There was no effect of barn treatment on pig performance. The results of this study suggest that the combined manure treatment increased hydrogen sulfide emissions but tend to reduce odor concentrations at the room exhaust and pit exhaust fans.

**Key Words:** swine facilities, gas emissions, odor

## Physiology

**235 Effects of feeding linseed meal on litter size in pigs.** K. A. Vonnahme<sup>\*1</sup>, J. Benz<sup>2</sup>, and R. Zimprich<sup>1</sup>, <sup>1</sup>*North Dakota State University, Fargo*, <sup>2</sup>*Kansas State University, Manhattan*.

Lignans found in the hull of flaxseed has been reported to have anti-estrogenic properties. When estradiol (E2) implants are given to ovariectomized (OVX) ewes, cell proliferation in the jejunum and uterus increases. However, when OVX ewes consumed defatted flax (i.e. linseed meal; LSM) for 14 d and then received an E2 implant, cell proliferation in the jejunum and uterus was blocked. Meishan conceptuses produce less E2 during the time elongation and have greater survival rates to term compared to the Yorkshire. It is our hypothesis that feeding LSM to early pregnant sows will decrease cell proliferation of the early conceptus, decrease E2 secretion and increase embryonic survival. Our specific objective was to determine how feeding LSM from d 1 to 15 after breeding influences litter size, fetal weight and placental weight at term. Sows were randomly placed in one of 3 groups: Group 1 (n=10) received a control diet (i.e. phytoestrogen-free) from d 1 to farrowing (d 0 = onset of heat); Group 2 (n=10) received a 12.5% linseed meal diet from d 1 to farrowing; Group 3 (n=10) received a 12.5% linseed meal diet from d 1 to 15 of gestation and control diet until farrowing. Piglets were weighed within 12 hours after farrowing. Placentas were weighed, and total litter size was recorded. There were no differences (P < 0.50) in average birth wt or placental wt which averaged  $1.54 \pm 0.04$  and  $0.28 \pm 0.09$  kg. There was no effect of treatment on stillborn (P = 0.41) and mummified fetuses (P = 0.76) (Group 1:  $0.66 \pm 0.50$  and  $0.56 \pm 0.45$ ; Group 2:  $1.60 \pm 0.47$  and  $1.00 \pm 0.43$ ; Group 3:  $1.20 \pm 0.47$  and  $0.90 \pm 0.43$ ). Number of live born piglets did not differ (P = 0.10) among treatments (Group 1:  $9.44 \pm 0.99$ ; Group 2:  $10.00 \pm 0.94$ ; Group 3:  $12.3 \pm 0.94$ ). However, total litter size (stillborn + live born) was increased (P = 0.05) in Group 3 ( $13.50 \pm 0.90$ ) compared to Groups 1 and 2 ( $10.11 \pm 0.95$  and  $11.60 \pm 0.90$ ). It appears that feeding LSM during the first 2 weeks after breeding may enhance litter size. The exact mechanism is not known. Furthermore, a large scale study needs to be conducted to validate these findings.

**Key Words:** linseed meal, littersize, pigs

**236 Thermoregulatory responses of sows to heat stress during three phases of production.** E. A. Coate<sup>\*</sup>, M. C. Lucy, T. J. Saffranski, P. A. Eichen, A. M. Williams, and D. E. Spiers, *University of Missouri-Columbia, Columbia*.

Heat stress affects sow performance during gestation, lactation, and breeding periods. The present study evaluated sow response to two thermal environments; Heat Stress (HS) and Thermoneutral (TN). Five groups of primiparous sows (n=58) were housed in the Brody Environmental Center. The TN and HS environments consisted of daily cyclic air temperatures (Ta) averaging 18.7 - 21.2°C and 24.6 - 30.7°C, respectively. Animals moved into chambers three weeks prior to farrowing and were randomly assigned to one of four HS/TN combinations for gestation, lactation, and breeding periods. Respiration rate (RR), ear skin (Tear), and rectal temperatures (Tre) were taken four times daily (0800, 1200, 1600, and 2000). Differences between HS and TN groups during gestation for Tre, Tear, and RR were 0.1°C, 4.0°C, and 20 bpm, respectively. There was little change in parameters as sows approached parturition. However, these parameters changed with advancing lactation. All groups rapidly increased Tre (P<0.05) by

1.0°C from Days 1 to 7 of lactation, with HS groups being 0.2°C above (P<0.05) TN groups. There was no change in the elevated Tear of HS sows during lactation, but a 4.0°C rise in Tear of TN sows from Days 1 to 11. In contrast, RR was 28 bpm higher (P<0.05) in HS versus TN animals and did not increase during lactation. All groups decreased Tre by more than 0.5°C after weaning to remain above gestation level, but with no difference (P>0.05) throughout the breeding period. All Tear values returned to gestation level within several days following weaning. A continuous decrease in RR (P<0.05) was noticed after Day 5 of the breeding period for all groups, with final values below gestation level. Differences in RR for HS and TN groups were only 10 bpm throughout this period. Daily rise in Ta throughout was initially noted by a rise in Tear followed by sequential increases in RR and Tre. The measured parameters of thermal status used in this study indicate that there are distinctly different responses to HS during gestation, lactation, and breeding periods for the sow.

**Key Words:** thermoregulation, heat stress, reproduction

**237 Productive and reproductive responses to heat stress for sows during a production cycle.** A. M. Williams<sup>\*</sup>, T. J. Saffranski, D. E. Spiers, P. A. Eichen, E. A. Coate, and M. C. Lucy, *University of Missouri, Columbia*.

Heat stress (HS) produces seasonal infertility in sows and decreases reproductive efficiency. The objective was to examine productivity in sows exposed to HS during a production cycle (gestation [gest], lactation [lact], and breeding). First parity Landrace/Large White F1 sows were rotated through chambers in the Brody Environmental Center for 58 d beginning in late gest. The ambient temperature sequences (treatment; trt) included either thermoneutral (TN; 18 to 20°C) or HS (24 to 30°C) for each production phase (TN-TN-TN [n=15], TN-HS-TN [n=14], HS-TN-HS [n=14] or HS-HS-HS [n=15] for gest-lact-breeding [20, 24, and 14 d, respectively]). Rectal temperature, body weight (BW), backfat (BF), loin eye area (LEA), feed intake (FI), piglet weights, and breeding performance were measured. Rectal temperature differed across phases and conditions (38.3 and 38.2, 39.5 and 39.2, 39.0 and 38.9°C [SEM < .04] for HS and TN during gest, lact, breeding, respectively; P<.001). Sows had similar FI (kg/d) when limit fed during gest ( $2.26 \pm .06$ ) and breeding ( $1.74 \pm .06$ ), but during lact (ad libitum) TN sows had greater FI (P<.01) than HS sows ( $3.68 \pm .14$  vs.  $3.11 \pm .14$  kg/d). There was no effect of trt on BW, BF, or LEA before farrowing ( $198 \pm 2$  kg,  $2.5 \pm .1$  cm, and  $51 \pm 1$  cm<sup>2</sup>) or after lact ( $169 \pm 2$  kg,  $2.0 \pm .1$  cm, and  $47 \pm 1$  cm<sup>2</sup>). Total born ( $11.7 \pm .4$ ), piglet birth weight ( $1.41 \pm .02$  kg) and total weaned ( $10.3 \pm .2$ ) were similar but piglet weaning weight was greater for TN compared with HS sows ( $6.2 \pm .1$  vs.  $5.7 \pm .1$  kg; P<.001). Weaning to estrus interval ( $4.5 \pm .3$  d), percentage inseminated sows after weaning (86%), subsequent farrowing rate (90%) and subsequent total born ( $10.7 \pm .3$  pigs per litter) were not different by trt (P>.10). In summary, HS decreased FI during lact and was associated with reduced piglet growth with no effect on sow BW, BF, or LEA. Breeding performance was not compromised by HS. We conclude that the HS slowed piglet growth perhaps through its effects on sow milk production without affecting sow body condition or breeding performance.

**Key Words:** heat stress, sow, reproduction

**238 Day of farrowing induction and suckling piglet performance.** H. M. Smith\*, A. M. Williams, C. C. Selby, and T. J. Safranski, *University of Missouri, Columbia*.

Today's commercial farrowing induction protocols were developed mostly in the 1970s-80s, and the average non-induced gestation length was found to be 114 d. No detrimental effects of prostaglandin protocols were found when inducing no more than two days early. "Normal" gestation length today has been reported to be 115-117 d. Therefore the objective of this study was to compare the effects of inducing sows on d 113, 114, and 116, with the expectation that most d 116 sows would farrow spontaneously. The genetic lines for females and males were Genetiporc F20 and G Performer, respectively. Records on 472 first and second-parity sows and 5493 piglets born alive were collected on a 3000 sow commercial farm in central Missouri in the summer of 2008. Sows were allocated to treatment group when they entered farrowing rooms. Parturition induction consisted of i.m. injections of Lutalyse™ at 0300 and 0600 on d 113, 114, or 116 of gestation to sows not farrowed or in labor; first day of mating was d 0. Oxytocin was given i.m. at 0530 the following day to sows not farrowed. Piglets were cross-fostered within 24 hours within treatment groups and processed on d 2. Average gestation length was  $114.00 \pm 0.62$ ,  $114.68 \pm 0.88$ , and  $115.27 \pm 1.32$  d for 113, 114, and 116 groups, respectively; spontaneous farrowing occurred in 8.33, 16.88 and 79.49% of sows. Litters were weighed at processing and the day before weaning with average lactation lengths of 22.12, 21.44, and 21.01 d for groups 113, 114, and 116, respectively. There was no difference among treatment groups in number born alive, mummies, litter weaning weight or litter ADG during lactation. Sows induced on d 116 tended to have more stillborns compared to sows induced on d 113 ( $P=0.07$ ), with means of  $0.80 \pm 0.71$  and  $0.56 \pm 1.11$ . Percentage of litters receiving medical intervention was 3.21, 3.80, and 5.73% and not different for d 113, 114, and 116 litters. Farrowing induction is still a valuable tool when average non-induced gestation length of the sow population is known. Further investigations in herds with higher morbidity are necessary to confirm results.

**Key Words:** farrowing induction, swine, morbidity

**239 Influence of exogenous progestin on ovarian function in beef cows.** R. A. Cushman\*<sup>1</sup>, J. R. Wood<sup>2</sup>, S. E. Echternkamp<sup>1</sup>, and A. S. Cupp<sup>2</sup>, <sup>1</sup>USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE, <sup>2</sup>University of Nebraska, Lincoln.

The ability to precisely regulate follicle recruitment and selection is critical to improving methods to control ovulation in beef cows. The objectives of the current study were to investigate the influence of exogenous progestins, commonly used in synchronization protocols, on ovarian function and determine if anti-Müllerian hormone (AMH) expression differed due to progesterone (P4) concentration. Low amounts of progestins have been reported to cause persistent follicles and decrease antral follicle number. Furthermore, AMH expression was found to be increased in the ovaries of women with cystic follicles. Therefore, we hypothesized that AMH would be increased in ovaries from cows treated with low levels of progesterone that developed persistent follicles. Beef cows ( $n = 12$ ) were either 1) injected with GnRH (100 µg, i.m.) and a controlled intravaginal drug releasing (CIDR) device (4-6 ng/ml P4) inserted for 7 d or 2) cows ( $n = 13$ ) were injected with prostaglandin and fed MGA (0.5 mg/(kg.d); < 1 ng/ml P4) for 14 d. At CIDR removal, or removal of melengestrol acetate (MGA), prostaglandin (25 mg, i.m.) was administered and 36 h later, ovaries were examined by ultrasonography and removed by flank laparotomy. Ovaries were weighed, the length and width measured, and surface follicles were counted. The MGA decreased ( $P \leq 0.05$ ) the total number of follicles detectable

by ultrasonography or surface count and increased the diameter of the largest follicle ( $P = 0.003$ ). Real-time RT-PCR analysis revealed that AMH transcripts were significantly reduced in the ovarian cortex of MGA cows compared with CIDR cows ( $P < 0.05$ ). Ovarian weight, length, and width did not differ between treatments. We conclude that persistent follicles in MGA-treated cows produce factors that negatively influence development of subordinate follicles. The decreased number of follicles results in decreased AMH expression in the ovarian cortex of cows with persistent follicles.

**Key Words:** beef, antral follicle count, anti-Müllerian hormone

**241 In vivo and in vitro expression of porcine zinc transporter (ZnT1) mRNA.** H. Tran\*, P. S. Miller, and T. E. Burkey, *University of Nebraska, Lincoln*.

Three separate, preliminary experiments were carried out to evaluate in vivo and in vitro expression of ZnT1 mRNA. In the first experiment, weaned pigs ( $n = 4$ ) were sacrificed and tissues (spleen, jejunum, ileum, liver, thymus and tonsil) were collected to evaluate ZnT1 mRNA expression via real-time, quantitative PCR (qPCR). In the second experiment, porcine jejunal epithelial cells (IPEC-J2) were employed to evaluate ZnT1 mRNA expression in cells exposed to low (40 µM) or high (80 µM) concentrations of zinc sulphate (ZnSO<sub>4</sub>), and a third experiment evaluated ZnT1 mRNA expression in IPEC-J2 cells exposed to low (50 µg/mL) or high (100 µg/mL) concentrations of gentamicin (GENT). Both in vitro experiments included wells with cells exposed to growth media devoid of antibiotics or additional zinc (CTL) and wells with cells exposed to CTL media + LPS (10 ng/mL). For both in vitro experiments, total RNA was harvested at 1.5, 3 and 6 h following addition of respective treatments, cDNA was synthesized, and qPCR was used to evaluate relative abundance of ZnT1 mRNA. In vivo, ZnT1 mRNA was detected in all tissues with the greatest expression observed in tonsil compared to spleen, jejunum, liver, ileum, thymus ( $P < 0.001$ ). In the second experiment, no treatment × time interaction was observed; however, supplementation of growth media with high concentrations of ZnSO<sub>4</sub> tended ( $P = 0.07$ ) to increase ZnT1 mRNA expression compared to CTL, LPS, and low concentrations of ZnSO<sub>4</sub> when averaged across all timepoints. In the third experiment, a treatment × time interaction ( $P < 0.005$ ) was observed. Cells treated with high concentrations of GENT had greater ZnT1 expression ( $P < 0.05$ ) at 3 h compared to all other treatments and cells treated with low or high concentrations of GENT had greater expression of ZnT1 mRNA ( $P < 0.05$ ) at 6 h compared to CTL and LPS-treated cells. The results of the 3 preliminary experiments indicate that ZnT1 mRNA is expressed in a panel of porcine tissues and that altering concentrations of zinc and antibiotics in growth media of IPEC-J2 cells may result in changes in ZnT1 mRNA.

**Key Words:** pigs, IPEC-J2, zinc transporter

**242 Influence of initiating luteal regression prior to treatment with GnRH on initiation of a new follicular wave and synchrony of estrus.** N. L. Hojer\*, S. D. Fields, S. F. Lares, B. L. Perry, and G. A. Perry, *South Dakota State University, Brookings*.

At the initiation of most CIDR protocols GnRH has been utilized to induce ovulation and reset follicular waves; however, its ability to initiate a new follicular wave is variable and dependent on stage of the estrous cycle. The objective of the current study was to determine if inducing luteal regression prior to the GnRH injection resulted in better control of follicular development and tighter synchrony of estrus. Cycling beef heifers ( $n = 22$ ) were allotted to one of two treatments.

Heifers received an injection PGF<sub>2α</sub> on d -9, an injection of GnRH and insertion of a CIDR on d -6, and a PGF<sub>2α</sub> injection and CIDR removed on d 0 (PG-CIDR), or heifers were treated with an injection of GnRH and insertion of a CIDR on d -7 and on d 0 an injection of PGF<sub>2α</sub> and CIDR removed (CIDR). Follicular development was determined daily by transrectal ultrasonography and blood samples were collected daily from d -11 through ovulation (d 2 to 4). Estrus was determined by visual observation with the aid of estrus alert patches. More heifers treated with PG-CIDR tended ( $P = 0.06$ ) to initiate a new follicular wave at the initiation of treatment compared to CIDR treated heifers (100% vs 73%, respectively). Interval to estrus following CIDR removal did not differ ( $P = 0.18$ ) between treatments ( $55.7 \pm 2.1$  and  $63.3 \pm 5.1$  h, respectively); however, the variance for the interval to estrus was reduced ( $P < 0.01$ ) in PG-CIDR (46.3) treated heifers compared to CIDR (291.6) heifers. In addition, there was a treatment by time interaction ( $P < 0.01$ ) on concentrations of estradiol. Estradiol was increased at time of CIDR insertion among PG-CIDR treated heifers compared to CIDR heifers. In conclusion, induction of luteal regression prior to an injection of GnRH tended to increase the percentage of heifers initiating a new follicular wave and increased the synchrony of estrus following CIDR removal.

**Key Words:** CIDR, estrous synchronization, ovulation

**243 Influence of post-AI diet change on uterine pH and blood urea nitrogen.** G. A. Perry\*, B. L. Perry, J. A. Walker, and C. L. Wright, *South Dakota State University, Brookings.*

Method of heifer development has been reported to have influence ADG and pregnancy success. Therefore, the objective of the current study was to evaluate differences in blood urea nitrogen (BUN) and uterine pH between heifers developed in a feedlot or on grass and then fed to maintain or gain weight following AI. Weaned heifers were developed to gain 0.45 kg/d for 6 mo either in the feedlot (n=54; LOT) or on grass (n=57; GRASS). All heifers were synchronized with a CIDR protocol and AI was performed following detection in estrus. Following AI all heifers were moved to a feedlot and each development group, LOT and GRASS, was divided into 3 groups. The groups were fed to maintain weight (MAIN; 6.4 kg hay and 0.01 kg urea/hd) or to gain weight on a diet high (HMP; 6.2 kg hay, 2.9 kg DDGS and 0.03 kg urea/hd) or low (LMP; 8.0 kg hay and 0.8 kg DDGS/hd) in metabolizable protein (n= 24, 44, and 43, respectively). Uterine pH and blood samples were collected from a subset of each group (n=3 LOT and 3 GRASS per post-AI group) on d 0, 7, and 11 after estrus. There was no difference ( $P > 0.20$ ) in BW between MAIN, HMP, or LMP heifers on the day of estrus ( $311 \pm 3.6$  kg), but heifers in the HMP and LMP group weighed more ( $P \leq 0.01$ ) than heifers in the MAIN group on d 11 ( $344 \pm 5.5$ ,  $338 \pm 5.5$  kg, and  $315 \pm 7$ ; respectively). Uterine pH did not differ ( $P > 0.14$ ) between LOT and GRASS heifers; however, uterine pH decreased ( $P < 0.01$ ) from d 7 to d 11 and was lower ( $P = 0.03$ ) among heifers fed HMP compared to heifers fed LMP or MAIN. There was no difference

( $P > 0.18$ ) between lot and grass developed heifers for BUN; however, there was a post-AI treatment by time interaction ( $P < 0.01$ ). LOT and GRASS heifers had similar ( $P > 0.14$ ) BUN concentrations on d 0. BUN concentrations in LMP heifers did not change from d 0 to d 7 or 11. BUN increased from d 0 to d 7 and 11 in both MAIN ( $P \leq 0.04$ ) and HMP ( $P < 0.01$ ). In summary, method of heifer development (LOT or GRASS) did not influence uterine pH or BUN when heifers were fed in a feedlot following AI; however, post-AI diet had an impact on both uterine pH and BUN.

**Key Words:** heifer development, uterine pH, BUN

**244 Characterization of progesterone receptor (PGR) mRNA isoforms in the endometrium of cyclic and pregnant pigs.** E. M. Sellner\*, J. W. Ross, C. S. Okamura, K. D. Wells, R. D. Geisert, and M. C. Lucy, *University of Missouri, Columbia.*

The down-regulation of the PGR within the luminal epithelium enables conceptus attachment and signaling within the porcine uterus. In humans, three PGR mRNA isoforms (PGR-A, PGR-B, and PGR-C) arise from alternative transcription start sites. The mRNA encode proteins with different N-termini that may confer distinct biological functions. The objective was to identify PGR isoforms in the pig and to characterize their mRNA expression in endometrium during the estrous cycle and pregnancy. Primer sets for quantitative RT-PCR were developed from porcine genomic and mRNA sequence and used to amplify porcine PGR fragments from cDNA. Based on cDNA sequencing and porcine genomic sequence, the porcine PGR mRNA is 4.3 kb and 84% identical to human PGR mRNA. The porcine PGR protein is 938 amino acids in length and 84% identical to human PGR protein. The porcine PGR protein was 75% identical to human PGR protein within the A/B (variable) region and was 97% identical to human PGR protein within the C, D, and E region. RT-PCR primers for PGR-B (5'-TCAGACT-GAAGTCGGGGAAC-3' and 5'-GGGTGAAATCTCCACCTCCT-3') and PGR-AB (region common to both PGR-A and PGR-B; 5'-GCTCCA-TGGTTCCACTTCTG-3' and 5'-GATGGGCACGTGGATAAAAT-3') were developed to study PGR regulation in endometrial tissue from cyclic (d 0, 5, 7.5, 10, 12, 13, 15, 17) and pregnant (d 10, 12, 13, 15, 17) pigs (n = 53 samples; minimum of 4 pigs per status and d). There was a tendency for an effect of d on PGR-B expression ( $P < .10$ ) because PGR-B mRNA was greater on d 0 ( $.52 \pm .07$ ) and d 5 ( $.51 \pm .07$ ) compared with d 7.5 ( $.31 \pm .07$ ) and d 15 ( $.30 \pm .05$ ) (remaining d were intermediate). The PGR-AB mRNA remained low through d 13 ( $.13 \pm .01$ ; d 0 to 13; cyclic and pregnant) and increased on d 15 in both pregnant ( $.90 \pm .07$ ) and cyclic ( $.41 \pm .07$ ) pigs ( $P < .001$ ). The PGR-AB mRNA remained elevated in pregnant pigs on d 17 ( $.33 \pm .06$ ). We conclude that PGR isoform mRNA abundance may change during the estrous cycle and pregnancy leading to functional differences in PGR action.

**Key Words:** progesterone receptor, pig, endometrium

## Ruminant Nutrition

**245 Performance and carcass characteristics of stocker cattle grazing dormant native range.** E. D. Sharman\*, P. A. Lancaster, G. G. Hilton, C. R. Krehbiel, H. T. Purvis, and G. W. Horn, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Provision of additional starch to suckling beef calves has been shown to increase marbling deposition. Glucose is the primary carbon source for fatty acid synthesis in i.m. fat, whereas, acetate is primarily utilized by

s.c. fat. Our objective was to examine potential effects of high-starch vs high-fiber energy supplements on the development of marbling by stocker cattle grazing dormant tallgrass native range (i.e., high ruminal acetate fermentation). Fifty-three fall-weaned Angus cross steer calves ( $268 \text{ kg} \pm 5.91$ ) grazed dormant tallgrass native range for 122 d and were supplemented with 1)  $1.02 \text{ kg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$  of a 40% CP pellet (CON) to meet their DIP requirement; 2) 40% CP pellet plus corn-based supplement at 1% BW (CORN); 3) 40% CP pellet plus soybean hull-based supplement

at 1% BW (SBH); or 4) 40% CP pellet plus distillers dried grains with solubles-based supplement at 1% BW (DDGS). Following the stocker phase, 3 randomly selected steers per treatment were harvested (intermittent harvest) for measurement of carcass characteristics. Remaining steers were transported to a feedlot and fed a dry-rolled corn finishing diet for 113 d before harvest. ADG by steers on dormant native range was 0.20<sup>a</sup>, 0.54<sup>c</sup>, 0.34<sup>b</sup>, and 0.35<sup>b</sup> kg•d<sup>-1</sup> for treatments 1-4, respectively, and was increased ( $P < 0.001$ ) by supplementation. ADG by steers supplemented with corn was greater ( $P < 0.001$ ) than the two high-fiber supplements. Marbling scores of the intermittent harvest steers were 120, 137, 150, and 157 (SEM = 25.4), respectively, (100 = practically devoid and 200 = traces) and were not different ( $P = 0.75$ ) among treatments. There were no differences in growth performance during finishing or final carcass measurements among treatments. Marbling scores were 385, 373, 406, and 399 (SEM = 19.7;  $P = 0.64$ ), respectively (300 = slight and 400 = small). These data indicate that supplementation strategies that differ in type and amount of supplement may not influence marbling development by stocker cattle wintered on dormant native range at relatively low energy intakes and rates of gain.

**Key Words:** stocker cattle, supplementation, winter grazing

**246 Effects of corn- vs. glycerol-based creep rations on calf and cow performance.** M. L. Van Emon\*<sup>1</sup>, R. P. Lemenager<sup>1</sup>, M. C. Claeys<sup>1</sup>, and S. L. Lake<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>University of Wyoming, Laramie.

The objectives of this study were to evaluate the effects of a glycerol-based creep ration compared with a corn-based creep ration on cow and calf performance. Cow-calf pairs ( $n = 178$ ) were blocked (calf weight, calf breed, and cow age) and randomly allotted into one of three treatments (3 reps/treatment): 1) corn based-creep ration, positive control (CON), 2) glycerol-based creep ration containing 15% glycerol (GLY), and 3) non-creep treatment, negative control (NEG). Rep one consisted of 34 second parity cows and 11 third parity cows. Rep one of each treatment were pastured on ~25 acres, with 15 cow-calf pairs. Multiparous cow-calf pairs that were allotted into the remaining two reps of each treatment were pastured on ~40 acres ( $n = 22-23$  pairs). Calves were fed the creep ration for 63 d prior to weaning. Calves were weaned at an average age of  $191 \pm 17$  d. Backfat depth, muscle depth, and marbling were evaluated for steer calves on study 7 d post-weaning via ultrasound. Initial and final BW of cows and calves and BCS of cows were taken on two consecutive days at the start of the trial and at weaning. Cow initial BW ( $665.0 \pm 55.3$  kg;  $P = 0.80$ ), initial BCS ( $5.23 \pm 0.47$ ;  $P = 0.47$ ), final BW ( $P = 0.35$ ), and final BCS ( $P = 0.46$ ) did not differ between treatments. Calf initial BW ( $P = 0.60$ ), calf age at the start of the trial ( $P = 0.60$ ), G:F ( $P = 0.28$ ), muscle depth ( $P = 0.35$ ), and marbling ( $P = 0.62$ ) did not differ between treatments. Creep feed DMI was greater ( $2.78$  vs.  $2.27$  kg;  $P = 0.04$ ) in the CON calves compared with the GLY calves. Calf total weight gain ( $97.8, 96.7$  vs.  $77.2$  kg;  $P = 0.002$ ), ADG ( $1.55, 1.53$  vs.  $1.23$  kg/d;  $P = 0.002$ ), and backfat depth ( $4.06, 4.15$  vs.  $3.15$  mm;  $P = 0.003$ ) were greater in the CON and GLY calves compared with the NEG calves. These data suggest that crude glycerin can be included at 15% of a pelleted creep ration as a substitute for corn without affecting cow or calf performance.

**Key Words:** calf performance, creep ration, glycerol

**247 Effects of starch versus fiber-based supplements on adipose tissue gene expression of stocker cattle grazing dormant native range.** P. A. Lancaster\*, E. D. Sharman, G. W. Horn, C. R. Krehbiel,

D. R. Stein, and U. DeSilva, Oklahoma Agricultural Experiment Station, Stillwater, OK.

Additional benefit to the stocker cattle production phase could be realized by influencing adipose tissue development prior to finishing. Previous research has indicated that nutritional management can affect marbling deposition in young calves. Fall weaned Angus-cross steer calves ( $N = 53$ ;  $268 \pm 5.91$  kg) were used to evaluate the effects of type of energy supplement on gene expression of adipose tissues. Steers grazed dormant tallgrass native range for 122 d and were supplemented  $5 \text{ d} \cdot \text{wk}^{-1}$  with  $1.02 \text{ kg} \cdot \text{hd}^{-1} \cdot \text{d}^{-1}$  of 40% CP pellet (CON), 40% CP pellet plus corn-based supplement at 1% BW (CORN), 40% CP pellet plus soyhull-based supplement at 1% BW (SBH), or 40% CP pellet plus distiller's dried grains with solubles-based supplement at 1% BW (DDGS). Following the stocker phase, 3 randomly selected steers per treatment were harvested and samples of perirenal (KPH) and s.c. adipose tissue obtained. Adequate amounts of i.m. adipose tissue could not be collected. Total RNA was extracted and gene expression determined using qRT-PCR. Performance and carcass data are presented elsewhere (Sharman et al., 2009). Treatment had no effect on glucose transporter 4, glucose-6-phosphate dehydrogenase, or glucose-6-phosphate isomerase gene expression in either adipose depot suggesting that glucose utilization was not altered by supplement type. Glycerol-3-phosphate dehydrogenase gene expression was greater ( $P < 0.05$ ) in both adipose depots for supplemented vs. CON steers (Fold change = 3.15 vs. 1.00 and 2.68 vs. 1.00 for s.c. and KPH, respectively). A significant ( $P < 0.10$ ) treatment by tissue interaction was observed for fatty acid synthase (FAS) and acetyl-CoA synthetase 2 (ACS2) expression. FAS and ACS2 expression were not altered by treatment in s.c., but were greater ( $P < 0.05$ ) for supplemented vs. CON steers in KPH (Fold change = 6.87 vs. 1.00 and 3.25 vs. 1.00, respectively). CORN steers were similar to SBH and DDGS steers for all genes examined. These data suggest that gene expression was influenced more by energy supplementation than type of energy source and may vary with adipose depot.

**Key Words:** adipose tissue, gene expression, stocker cattle

**248 Effect of length of time between maternal separation and shipping on feedlot performance and carcass merit of ranch-direct beef calves weaned during the fall.** J. W. Bolte\*<sup>1</sup>, J. R. Jaeger<sup>1</sup>, T. B. Schmidt<sup>2</sup>, D. U. Thomson<sup>1</sup>, B. J. White<sup>1</sup>, R. L. Larson<sup>1</sup>, L. A. Pacheco<sup>1</sup>, N. A. Sproul<sup>1</sup>, M. D. Thomas<sup>1</sup>, and K. C. Olson<sup>1</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Mississippi State University, Starkville.

Ranch-of-origin weaning periods of between 30 and 60 d are recommended for preconditioning beef calves. Our objective was to test this recommendation for ranch-direct calves aged 160 to 220 d and weaned during the fall. Angus x calves ( $n=433$ ) were stratified by age and assigned randomly to 1 of 5 weaning dates that corresponded to the length of time between maternal separation and shipping to an auction market: 60, 45, 30, 15, or 0 d. Calves were vaccinated against common diseases 14 d before weaning and again at maternal separation. On a common shipping date (d 0), calves were transported 3 h to an auction market and held for 12 h. Calves were then transported 1 h to a feedlot. All calves were fed the same diet ad libitum during finishing. Calves were fed to reach an average of 10 mm of backfat at the 12th rib and harvested in 3 groups. Intake of DM during the first 30 d on feed increased linearly ( $P > 0.01$ ) as the length of the ranch-of-origin weaning period increased; however, DM intake was similar ( $P > 0.3$ ) between treatments from d 30 in the feedlot to harvest. Calf ADG and G:F were similar ( $P > 0.2$ ) between treatments from receiving to d 232; however, ADG and G:F tended to increase linearly ( $P < 0.06$ ) with longer weaning

periods from d 232 to harvest. Days on feed decreased linearly ( $P=0.05$ ) with successively longer weaning periods. Dressing percentage, HCW, marbling, and longissimus-muscle area were similar ( $P>0.15$ ) between treatments. Yield grade and KPH increased linearly ( $P<0.04$ ) and 12th-rib fat thickness tended to increase linearly ( $P=0.06$ ) with successively longer weaning periods. Liver and lung scores were similar ( $P>0.3$ ) between treatments. For ranch-direct calves weaned during the fall, successively longer ranch-of-origin weaning periods decreased days on feed but increased carcass fat relative to shipping calves immediately after maternal separation.

**Key Words:** preconditioning, weaning, carcass merit

**249 The effects of source of energy on performance, ultrasonic, and carcass characteristics of early-weaned steers.** K. M. Retallick\*, D. B. Faulkner, T. G. Nash, and D. W. Shike, *University of Illinois, Urbana*.

Data from 246 Angus and Angus  $\times$  Simmental steer calves ( $BW=128 \pm 2$  kg) were utilized to determine the effect of source of energy on performance, ultrasonic, carcass, and economic characteristics. Steers were early weaned at an average of 65 days of age and randomly assigned to 21 pens with seven pens per treatment. Treatments investigated were: intermediate starch (IS), low starch (LS), and very low starch (VLS). After the 111 d growing phase, each treatment group (IS, LS, VLS) was randomly re-allotted to IS, LS, VLS finishing diets to obtain a  $3 \times 3$  factorial experimental design. Steers were individually fed during the 156 d finishing phase. At day 0, 56, 105, and 154 of the finishing phase, steers were weighed and ultrasounded for back fat and marbling. Steers were harvested on day 269 and standard carcass measurements were taken. The growing phase detected no significant performance differences. When starch level increased in the growing treatments (GT), finishing phase DMI decreased linearly ( $P=.03$ ), and ADG remained similar resulting in a linear improvement ( $P<.01$ ) in feed efficiency. As starch level increased, finishing treatment (FT) effects were similar to GT except that ADG linearly increased ( $P<.01$ ). As level of starch increased during the growing phase, marbling and back fat linearly increased ( $P<.01$ ). As starch level increased, GT caused a linear finishing phase decrease ( $P<.01$ ) in rate of marbling, but final marbling scores did not differ. As starch level increased, FT linearly increased back fat ( $P<.01$ ) and tended ( $P=.13$ ) to increase rate of marbling. As level of starch increased in both GT and FT, cattle had linearly ( $P<.01$ ) less desirable yield grades and more desirable quality grades. As level of starch increased for both GT and FT, feed costs linearly increased ( $P<.01$ ); however, profitability did not differ significantly. In this study, level of starch impacted performance, ultrasonic, and carcass characteristics; however, profitability differences weren't significant.

**Key Words:** steer, energy, quality

**250 The effects of replacing corn with soybean hulls on performance and carcass characteristics of feedlot steers.** M. H. Ramos\*, M. Kerley, Y. Liang, and S. J. Harris, *University of Missouri, Columbia*.

The objective of this experiment was to determine the effect of replacing corn with Soyhulls (SH) in the diet of feedlot steers. Three diets were fed, one diet was corn-based (CORN) and two were SH-based with no corn and either no hay (NCNH) or 10% hay (NCH) included.

Other dietary ingredients consisted of distillers dried grains (25%) and glycerol (10%). Steers used in this experiment were fed for 188 days, and slaughtered when visual assessment estimated that the majority of the calves had reached a low choice carcass quality. Five head of steers were assigned to each pen with four pens per treatment. Pen assignment was done to create similar average body weights across pen. Growth performance and carcass characteristics of steers fed experimental diets were measured. Initial weight (306 Kg) was not ( $P > 0.05$ ) different between treatments as designed. Cattle fed NCH had similar ( $P > 0.05$ ) ADG as cattle on CORN treatment but higher ( $P < 0.05$ ) ADG than the NCNH treatment, although no differences ( $P > 0.05$ ) were measured among treatments for final weight. Animals fed CORN diet consumed less ( $P < 0.05$ ) feed than animals fed NCNH and NCH diets. The CORN and NCH diets resulted in similar gain to feed ratios and the NCNH diet resulted in lower ( $P < 0.05$ ) gain to feed ratios when fed to calves in this experiment. No significant ( $P > 0.05$ ) differences were measured among diets for HCW, QG, BF, REA and YG. Steers fed a SH diet with no corn gained weight, had a gain to feed ratio, and carcass value similar to calves consuming a corn-based diet.

**Key Words:** soyhulls, feedlot cattle, by-product

**251 Timing of Optaflexx inclusion in feedlot diets on performance and carcass characteristics of beef steers.** J. M. Kelzer\*<sup>1</sup>, C. R. Dahlen<sup>2</sup>, G. I. Crawford<sup>3</sup>, and A. DiCostanzo<sup>1</sup>, <sup>1</sup>*University of Minnesota, St. Paul*, <sup>2</sup>*Northwest Research and Outreach Center, University of Minnesota, Crookston, MN*, <sup>3</sup>*Extension Regional Center, University of Minnesota, Hutchinson, MN*.

One-hundred sixty crossbred yearling steers averaging  $432 \pm 44$  kg initial BW were blocked by weight (Heavy; HY, and Light; LT) and allotted to one of 16 pens to determine timing of Ractopamine Hydrochloride (Optaflexx) inclusion on feedlot performance and carcass characteristics. Light and heavy replicate pens were randomly paired before assigning treatments. Treatments included: 1) no Optaflexx (200 mg/steer daily) fed to HY or LT (CON/CON), 2) Optaflexx not fed to HY but fed to LT (CON/OPTA), 3) Optaflexx fed to HY but not to LT (OPTA/CON), and 4) Optaflexx fed to both HY and LT (OPTA/OPTA). Steers received a common diet (1.39 Mcal NEg/kg DM, 12.5% CP, 0.7% Ca, 0.35% P) consisting of 58% HMC, 19% DRC, 19% corn silage, and 4% supplement containing monensin sodium once daily. All steers were implanted on d 1 with 100 mg trenbolone acetate and 14 mg estradiol benzoate. Treatments were applied the final 34 of 69 (HY) or 40 of 96 d (LT) on feed. During the treatment period, steers fed OPTA consumed more ( $P < 0.05$ ) DMI ( $11.3$  vs.  $10.7 \pm 0.2$  kg/d). Heavy steers had greater ( $P < 0.05$ ) ADG ( $1.9$  vs.  $1.4 \pm 0.1$  kg/d) and improved ( $P < 0.05$ ) G:F ( $0.17$  vs.  $0.13 \pm 0.01$ ). Hot carcass weights were heavier ( $P < 0.05$ ) for OPTA and HY steers (362 vs 357 and 366 vs. 354  $\pm 1.1$  kg). Heavy steers had greater ( $P < 0.05$ ) yield grades ( $3.2$  vs.  $2.8 \pm 0.1$ ), tended ( $P < 0.10$ ) to have lower marbling score (529 vs. 549  $\pm 7.8$ ), smaller ( $P < 0.05$ ) LM area ( $81.7$  vs.  $84.2 \pm 0.8$  cm<sup>2</sup>), and greater ( $P < 0.05$ ) 12th rib backfat ( $1.6$  vs.  $1.4 \pm 0.04$  cm). Feeding OPTA to both HY and LT steers led to greater ( $P < 0.05$ ) HCW. However, feeding OPTA only to LT steers led to similar HCW as feeding OPTA to both HY and LT steers. Strategically feeding Optaflexx only to light weight cattle in a pen may be a viable alternative to feeding Optaflexx to all cattle in a pen.

**Key Words:** feedlot cattle, Optaflexx, feedlot performance

**252 Comparison of Revalor XS, a new single dose implant, to a Revalor IS and Revalor S implant strategy in finishing steers.** C. A. Nichols<sup>\*1</sup>, G. E. Erickson<sup>1</sup>, J. T. Vasconcelos<sup>1</sup>, M. N. Streeter<sup>2</sup>, B. D. Dicke<sup>3</sup>, D. J. Jordan<sup>3</sup>, R. J. Cooper<sup>3</sup>, T. L. Scott<sup>3</sup>, and T. J. Klopfenstein<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Intervet/Shering-Plough, Inc., Millsboro, DE, <sup>3</sup>Cattlemens Nutrition Services, Lincoln, NE.

A commercial feedlot experiment was performed to compare the effects of a Revalor IS/ Revalor S (RevIS-S) implant strategy to a Revalor XS (RevXS) single implant strategy on performance and carcass characteristics of feedlot cattle. Yearling steers (1,356; BW = 313.3 ± 16.0 kg) were used in a randomized complete block design trial with initial arrival date as the blocking factor. Steers were allocated to pens based on sorting every 2 steers into one of two pens prior to processing. Pens were assigned randomly to 1 of 2 implant treatments. Cattle on the RevIS-S treatment were reimplanted on d80 with Revalor S. Mean days on feed was 157. Diets consisted of 54.9% dry rolled corn, 35% WDGS, 5.5% mixed hay and 4.6% liquid supplement (DM basis). Live performance was calculated from pen BW shrunk 4%. Data were analyzed using the MIXED procedure of SAS and Chi Square distribution analysis for quality and yield grade. There were no differences (P > 0.10) in DMI due to treatment. Using final BW calculated from HCW there were no differences (P > 0.10) in final BW, ADG, or G:F. No differences in final BW, ADG and G:F (P > 0.10) were observed for live performance. Marbling score, 12th rib fat, LM area and yield grade were unaffected (P > 0.10) by implant strategies. Steers on the RevXS treatment had a greater number of low choice carcasses (P < 0.01) and a lower number of select carcasses (P < 0.01) compared to RevIS-S, with 58% of RevXS cattle grading low choice and 50% of RevIS-S cattle grading low choice. Steers on the RevXS treatment tended to have a greater (P = 0.11) number of USDA Yield Grade 5 carcasses. Aside from improved quality grade, cattle implanted with Revalor XS performed similar to cattle implanted initially with Revalor IS followed by Revalor S.

**Key Words:** beef cattle, finishing performance, implant strategy

**253 Evaluation of component TE-IS with Tylan followed by component TE-S with Tylan vs. a single component TE-200 with Tylan or a single Revalor XS implant in beef finishing steers.** C. A. Nichols<sup>\*1</sup>, J. T. Vasconcelos<sup>2</sup>, G. E. Erickson<sup>1</sup>, S. A. Furman<sup>2</sup>, J. J. Sindt<sup>3</sup>, and T. J. Klopfenstein<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>University of Nebraska Panhandle Research and Extension Center, Scottsbluff, <sup>3</sup>YelLife, Inc., West Des Moines, IA.

A finishing trial was conducted to evaluate the effects of a Component TE-IS/TE-S with Tylan (IS-S) implant strategy to a Component TE-200 with Tylan (TE-200) or a Revalor XS (Rev-X) single implant strategy on performance and carcass characteristics of feedlot steers. The three treatments provide varying activity based on concentrations of hormone and time with TE-IS (16 mg estradiol + 80 mg trenbolone acetate), TE-S (24 mg estradiol + 120 mg trenbolone acetate), TE-200 (20 mg estradiol + 200 mg trenbolone acetate) and Rev-X (40 mg estradiol + 200 mg trenbolone acetate). Three hundred and sixty yearling steers (initial BW = 323.1 ± 21.7 kg) were used in a randomized complete block design trial. Cattle were individually weighed, stratified by BW, and assigned randomly to 24 pens containing 15 animals each. Pens were assigned randomly to 1 of 3 treatments (8 pens per treatment). Cattle were on feed for 167 d. The only treatment with cattle reimplanted on d85 was the IS-S. The finishing diet consisted of 55.6% dry rolled corn, 30.0% WDGS, 8.0% alfalfa hay, 6.0% liquid supplement and .4% limestone for additional Ca (DM basis). Data were analyzed using the MIXED procedure of SAS. Final BW, DMI and ADG were unaffected (P > 0.05)

by implant strategy. There was a significant difference (P < 0.01) in G:F. Steers on the IS-S treatment had a greater (P < 0.02) G:F (0.174) when compared to Rev-X (0.167) and TE-200 (0.164). No differences (P > 0.05) were observed for HCW, 12th rib fat, percentage USDA Choice and calculated USDA Yield Grade across treatments. Cattle implanted with Rev-X had greater (P < 0.05) marbling scores (595) than IS-S (556). Our results suggest that G:F is improved with reimplanting. Marbling may improve when utilizing a single implant strategy rather than reimplant.

**Key Words:** beef cattle, finishing performance, implant strategy

**254 Residual feed intake, phenotype, and fertility in yearling beef females.** K. S. Shaffer<sup>\*</sup>, W. R. Wagner, J. E. Warren, and E. E. D. Felton, West Virginia University, Morgantown.

Sixty-seven spring born yearling beef heifers of English breed types were used to determine the relationships between residual feed intake (RFI) and growth rate, body composition, mature size, and fertility. Heifers were housed in a drylot facility during the trial period. Individual feed intake, BW, BCS, hip height (HH), and carcass ultrasound measurements were collected over a period of 92 d. Individual feed intake and estrous activity data were collected using the GrowSafe 3000E System (GrowSafe Systems, Ltd., Airdrie, Alberta, Canada) and the HeatWatch Estrus Detection System (CowChips, Inc., Denver, CO), respectively. Heifers averaged 378.4 ± 16.2 days of age (DOA) and 330.8 ± 27.0 kg BW on d 1 of the trial period. Mean ADG was 1.01 ± 0.18 kg/d. A slight relationship (P < 0.05) existed between RFI and both ultrasound rib (RIF) and rump fat (RUF) (r=0.29 and 0.26, respectively) on d 1 and strengthened (P < 0.001) to r=0.43 and r=0.39 on d 92, respectively. No other significant correlations with RFI were observed. For further analysis of trait differences, heifers were classified into groups (POS; mean RFI= 2.57 vs. NEG; -2.35 and HIGH; mean RFI= 3.45, MEDIUM; 0.03, and LOW; -3.48) based on RFI (kg DM/d) value. POS heifers possessed more RIF and RUF (0.21 vs. 0.18 in. and 0.25 vs. 0.21 in., respectively; P < 0.05) than NEG heifers at end of test. Gain, BCS, BW, DOA, frame score (FS), and conception rate (CR) were not different between groups. MEDIUM heifers tended to have more RUF (P = 0.08) than LOW and less RUF (P = 0.10) than HIGH RFI heifers on day 92; however, d 92 RIF was not different for MEDIUM and LOW heifers while MEDIUM heifers had significantly less RIF (P < 0.05) than HIGH RFI heifers. MEDIUM heifers also exhibited less IMF (P < 0.05) at d 92 than HIGH RFI heifers. RFI in yearling beef females is correlated with subcutaneous fat measures with higher (more positive) RFI females possessed the greatest amount of subcutaneous fat.

**Key Words:** residual feed intake, beef, heifers

**255 Challenges in understanding mycotoxin related research: Real world applications.** D. E. Duarte<sup>\*1</sup> and G. Pena<sup>2</sup>, <sup>1</sup>Novus International Inc., St. Louis, MO, <sup>2</sup>Utah State University, Logan.

Mycotoxins are undesirable, but mostly unavoidable, mold produced feed contaminants. The level of mycotoxins in foods and feed can fluctuate widely and vary significantly from year to year. These fluctuations depend on many factors, including adverse conditions that favor fungal invasion and growth either in the field or during storage. Apart from their threat to public health, mycotoxins are also associated with significant economic losses for both crops and animals. Although several hundred mycotoxins have been described in the scientific literature, less than 10 have been extensively studied since the discovery of aflatoxin in the early

1960s. Mycotoxins can increase disease incidence and reduce production efficiency in livestock. They can cause dermal toxicity, reproductive effects, carcinogenicity, neurotoxicity, teratogenicity, nephrotoxicity and hepatotoxicity. Additionally, mycotoxins may affect immune function and cause lipid peroxidation. In spite of current research advances, applied aspects of mycotoxicology are either limiting or difficult to extrapolate into the real world. This review will attempt to discuss some of the most common problems related to field mycotoxicology, including analytical procedures and interpretation, mold/plant interactions, toxin symptomatology, and detoxification/decontamination strategies.

**Key Words:** mycotoxins

**256 Performance, metabolism and immunity in livestock fed diets contaminated with *Fusarium* mycotoxins.** T. K. Smith\*, *University of Guelph, Guelph, Ontario, Canada.*

A series of experiments was conducted with lactating dairy cows, gestating and lactating sows and mature horses to determine the effect of feed-borne *Fusarium* mycotoxins on performance, metabolism and immunity. Blends of naturally-contaminated corn and wheat were found to contain deoxynivalenol (DON, vomitoxin) as the major contaminant. In all experiments, animals were fed: (1) control diet (2) diet containing contaminated grains or (3) contaminated grains + 0.2% polymeric glucomannan mycotoxin adsorbent (GMA, Mycosorb, Alltech Inc., Nicholasville, KY). Sows were fed experimental diets for 21 days before farrowing and for 21 days post-farrowing. Horses were fed the experimental diets for 21 days. Dairy cows were fed test rations as TMR for 56 days. The feeding of contaminated grains significantly reduced sow weight gain during gestation and this was partially prevented by the feeding of GMA. The feeding of contaminated grains significantly increased the incidence of stillborn piglets, however, and this was prevented by the feeding of GMA. The feeding of diets containing contaminated grains in the lactation period resulted in significantly reduced feed intake and greater weight loss compared to controls. Horses fed contaminated diets had significant reductions in feed intake and elevated blood gamma-glutamyltransferase activities compared to controls. The feeding of GMA prevented these effects. There was no effect of diet on milk production, feed intake, somatic cell counts or milk composition when fed to dairy cows. The feeding of contaminated feedstuffs, however, significantly reduced serum concentrations of IgA and also resulted in a significant elevation of serum urea concentrations. The feeding of GMA prevented these effects. It was concluded that dairy cows, mature pigs and horses are all adversely affected by feed-borne *Fusarium* mycotoxins and that contaminated feedstuffs should be fed only with caution and with an appropriate mycotoxin adsorbent.

**Key Words:** *Fusarium* mycotoxins, pigs, horses

**257 Mycotoxin effects and their prevention in cattle.** L. W. Whitlow\*, *North Carolina State University, Raleigh.*

Ruminants consume mycotoxins from a diverse milieu of wet and dry feedstuffs, including grains, by-product feeds, and various forms of forages. Forages can harbor mycotoxins that are different from those found in grains. Wet feeds present additional risks. Partial ruminal degradation provides protection against high concentrations of mycotoxins; however, may contribute to chronic toxicities resulting from long term exposure to lower levels of mycotoxins.

The major classes of mycotoxins include the ergot alkaloids, aflatoxins, trichothecenes, fumonisins, zearalenone, and ochratoxin. In ruminants,

aflatoxin targets the liver, affects immunity, reproduction and performance and contaminates milk. Trichothecenes are known to affect ruminants causing anorexia, weight loss, digestive tract irritation, altered rumen fermentation, immune suppression, reproductive disorders and death. Fumonisin affects ruminants through reduced intake and liver damage. Zearalenone is associated with estrogenic effects in ruminants. Mature ruminants are not very sensitive to ochratoxin, however, tissue residues can occur, and pre-ruminant calves can be affected.

Beyond the major mycotoxins, ruminant feeds such as silage and wet feeds may be contaminated with other mycotoxins including PR toxin, mycophenolic acid, roquefortines, patulin, penitrem A, gliotoxin, fumigaclavine A and C, fumitremorgens A and B, sterigmatocystin, satratoxins and others. *Penicillium* produced mycotoxins should receive more rigorous investigation because of the prominence of *Penicillium* in silage and because *Penicillium* produced mycotoxins have been associated with ruminant toxicity. Some of the recognized forage mycotoxin problems include fescue toxicosis, ryegrass staggers, paspalum staggers, slobber syndrome, locoism, photosensitization and sweet clover disease.

**Key Words:** mycotoxins

**258 Question for the ethanol industry: What are you doing about mycotoxins?** M. L. Gibson\*, K. Karges, M. L. Giesemann, M. K. Frederking, and S. E. Van Hulzen, *POET Nutrition, Souix Falls, SD.*

The modern fuel ethanol industry is based on fermenting corn into three products: ethanol and CO<sub>2</sub> (from starch), and distillers dried grains with solubles (DDG/S; from the non-starch residue). These three products each comprise approximately 1/3 of the end-product stream. As a result, any substance in the corn — that is not fermented — will be concentrated 3-fold in the resulting DDG/S. This includes mycotoxins which are (unfortunately) not destroyed during either the fermentation or drying processes. Although mycotoxins are easily quantified in corn, a good, representative sample is very difficult to obtain from a bulk shipment. Therefore, any accurate determination of mycotoxins in the DDG/S must be obtained from the product itself. There are two predominant methods for determining mycotoxins in DDG/S: ELISA and HPLC. Further, mycotoxin contamination of corn may vary widely primarily due to growing and storage conditions which, in turn, may vary widely on a regional and annual basis. This paper will explore the difficulties surrounding mycotoxin determination — in both corn and DDG/S. It will also explore the occurrence of mycotoxins due to annual and geographic variation. We will examine the dietary effect of mycotoxin contaminated DDG/S: where and how it is fed and what is the overall contribution to production livestock. Finally, we will explore new ethanol processing techniques and their effect on the fate of mycotoxins in the final products.

**Key Words:** distillers grains, mycotoxins

**259 Supplementing dried distillers grains to growing calves on smooth bromegrass pastures.** A. K. Watson\*, M. K. Luebbe, T. J. Klopfenstein, G. E. Erickson, K. R. Brink, and W. H. Schacht, *University of Nebraska, Lincoln.*

Dried distillers grains with solubles (DDGS) are a good source of both undegradable protein and energy, and have been shown to increase ADG in animals consuming low and high quality forages. Forty-five steers grazing smooth bromegrass (312 kg±15 kg) were used in a randomized complete block design to measure animal and pasture performance. Treatments included control (CON) with no treatment assigned, fertil-

ized (FERT) with 88 kg N/ha, or supplemented (SUPP) at .6% BW with dried distillers grains daily (2.09-2.55 kg/hd). Cattle were stocked at 6.8 AUM/ha for CON and 9.9 AUM/ha for FERT and SUPP from April 24 to September 26, 2008. Interim weights were taken at the end of each of five grazing cycles (24 d in cycles 1 and 5, and 36 d in cycles 2, 3, and 4). Six paddocks were rotationally grazed within each cycle. Pasture was the experimental unit and was replicated 3 times. Pastures were strip-grazed within each cycle while put and take cattle and days within each strip were adjusted to maintain similar grazing pressure among treatments. Diet collections were taken throughout the grazing season via ruminally fistulated steers. Forage quantity was measured by a combination of hand clipping randomly-located quadrats (.36 m<sup>2</sup>) and a calibrated drop disk method. Steers on CON gained .65 kg/d and FERT gained .67 kg/d (P=0.60). The SUPP gained more at .86 kg/d (P<0.01). Interim performance showed a quadratic decrease in cumulative ADG for cattle over the entire grazing season. This indicates a steady decrease in forage quality with improvement in cycle 5 due to regrowth. However, as forage quality declined there was an increased response to supplementation. Forage availability (kg/ha) was greatest for FERT and least for CON. Across cycles and treatments there was a high level of forage availability the first 2 cycles and then a steady decrease. Dried distillers grains can be used as a substitute for forage and (or) nitrogen fertilizer by improving animal performance in smooth bromegrass pastures.

**Key Words:** dried distillers grains, fertilizer, forage

**260 Effects of level of dried distiller's grains supplementation on native pasture and subsequent effects on wheat pasture gains.** K. H. Jenkins<sup>\*1</sup>, J. C. MacDonald<sup>1,2</sup>, F. T. McCollum III<sup>3</sup>, and S. H. Amosson<sup>3</sup>, <sup>1</sup>Texas AgriLife Research, Amarillo, <sup>2</sup>West Texas A&M University, Canyon, <sup>3</sup>Texas AgriLife Extension, Amarillo.

One hundred twenty crossbred steers (225 kg, ± 16.8 kg) were stratified by weight, blocked by supplementation group, and randomly assigned to treatment to determine the effects of level of dried distiller's grains (DDG) supplementation on native pasture gains, subsequent wheat pasture gains, and supplement efficiency. Steers grazed dormant rangeland (CP = 8.75%; calculated TDN = 51.6%) for 56-d from October 12 through December 7. Each block was supplemented 3X weekly with the equivalent of 7-d of corn DDG at 0, 0.25, 0.50, or 0.75% BW/d (DM basis). On rangeland, ADG increased linearly (0.27, 0.49, 0.65, and 0.79 kg/d respectively; P < 0.0001) and tended to be quadratic (P = 0.16) with level of DDG. After grazing rangeland, block 1 was moved to wheat pasture for 76-d to determine if the rangeland supplement influenced gain on wheat pasture. Cattle did not receive protein/energy supplement while grazing wheat. During wheat grazing the non-supplemented steers compensated and at the end of the 76-d wheat grazing period BW was not different between the non-supplemented and 0.25% BW supplement groups (285 kg vs. 284 kg, respectively). However, final BW tended to be greater for the 0.50 and 0.75% BW groups than the non-supplemented group (298, 298, 285 kg, respectively; P < 0.18). During wheat grazing, the non-supplemented steers overcame 46 and 53%, respectively, of the initial weight difference compared to the 0.50 and 0.75% BW supplement groups. Supplement efficiency while grazing range was 0.427, 0.369, and 0.338 kg added gain/kg supplement DM, respectively, for 0.25, 0.50, and 0.75% BW treatments. However, total system efficiency was reduced to -0.094, 0.209, and 0.175 kg added gain/kg supplement DM, respectively, after grazing wheat pasture. Supplementing corn DDG efficiently improved gains of steers grazing dormant range in the Texas Panhandle. However, compensatory gains

during the subsequent wheat grazing period decreased or eliminated the efficiency of supplementation.

**Key Words:** distiller's grains supplementation, compensatory gain, wheat pasture

**261 Comparing the energy value of wet distillers grains to dry rolled corn in forage based diets.** B. L. Nuttelman<sup>\*</sup>, M. K. Luebbe, J. R. Benton, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

An experiment was conducted over 67 d to compare the energy value of wet distillers grains (WDGS) to dry rolled corn (DRC) in forage based diets. One hundred and sixty steers (285 ± 19 kg) were blocked into two weight groups, stratified within block, and then assigned randomly to one of ten pens (16 steers/pen). Pens were assigned randomly to one of two treatments: steers consuming a forage based diet containing either 1) 25% WDGS or 2) 33% DRC plus 3.35% high bypass soybean meal and 0.9% urea. Sorghum silage was fixed at 35% of the diet for both treatments. Grass hay was included at 39.05% and 26.41% for WDGS and DRC, respectively. Diets were formulated using the NRC (1996) model and were formulated to meet energy and meet or exceed metabolizable protein (MP) requirements for a targeted gain of 1.02 kg/d. Initial BW was not different (P=0.48). By design, DMI was similar between treatments (P=0.72). Although not different (P > 0.11), ADG and G:F were numerically improved for WDGS (0.08 kg and 0.03 kg, respectively). The NRC (1996) model predicts animal performance using feed intake and dietary energy content. Therefore, energy content of the feed can be predicted if ADG and DMI are known. The NRC energy adjusters were used to predict actual ADG on the DRC diet with the TDN of corn set at 83%. The TDN value of WDGS was calculated to be 108%. Therefore the energy value of WDGS was estimated to be 130% the value of corn. This trial confirms that WDGS has greater energy than corn in forage based diets, which is likely due to the low level of starch and energy density of fat, undegraded protein, and corn fiber.

**Key Words:** beef cattle, energy value, wet distillers grains

**262 Utilizing wet corn gluten feed instead of roughage during grain adaptation in finishing feedlot cattle.** T. J. Huls<sup>1</sup>, M. K. Luebbe<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, G. E. Erickson<sup>\*1</sup>, W. A. Griffin<sup>1</sup>, R. A. Stock<sup>2</sup>, and D. R. Mark<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Cargill, Blair, NE.

An experiment was conducted to determine the performance and carcass characteristics of feedlot steers adapted to grain using two different adaptation systems. Two hundred forty finishing steers (BW = 270 ± 14 kg) were blocked by BW, stratified within block, and assigned randomly to pens to determine if wet corn gluten feed could be used to adapt cattle to finishing rations instead of forage and if this is economically feasible. Steers were fed either decreasing Sweet Bran<sup>®</sup> (Cargill, Blair, NE) inclusion while increasing corn (WCGF), or decreasing alfalfa hay inclusion, while increasing corn (CON). Treatments were applied only during grain adaptation (26 d) and all steers were finished on a common diet (147 d) containing 35% gluten feed. Adaptation periods were 5, 7, 7, and 7 d for periods 1, 2, 3, and 4, respectively. Dry matter intake was summarized by adaptation period, 5 d on finishing ration, and 85 d performance. For adaptation periods 1, 3, 4, 5 d on finishing ration, and 85 d DMI did not differ (P > 0.19). Steers fed CON treatment had greater (P < 0.01) DMI during adaptation period 2. Steers adapted with WCGF had greater (P < 0.04) 85 d BW, ADG, and G:F than CON adapted steers. Steers adapted using WCGF had greater (P

< 0.01) final BW, ADG, and G:F. Hot carcass weight was greater ( $P = 0.01$ ) for WCGF fed steers. Marbling score and fat depth were not different ( $P > 0.31$ ) indicating steers were finished to a similar end point. Calculated USDA Yield Grade and LM area were not different between treatments ( $P > 0.13$ ). Profit was greater when steers were adapted to finishing diets using WCGF compared to alfalfa hay. This trial indicates that wet corn gluten feed can be used to adapt cattle to finishing diets instead of forage. Decreasing WCGF inclusion instead of forage is a viable method for adapting feedlot cattle to high-concentrate diets and reduces forage use by feedlots.

**Key Words:** feedlot cattle, grain adaptation, wet corn gluten feed

**263 Effects of self fed by-products on pasture housed finishing beef cattle on live animal performance and carcass traits.** D. D. Kiesling\*, D. G. Morrical, W. D. Busby, D. R. Strohhahn, M. S. Honeyman, J. H. Sellers, and D. L. Maxwell, *Iowa State University, Ames.*

Eighty-two crossbred yearling steers with an initial weight of 375 kg ( $\pm 1$  kg BW) were utilized in a 134 d trial at the Neely-Kinyon Research Farm in southwest Iowa. A 2 x 2 factorial design with implanted and non-implanted cattle by a corn/dried distillers grain with solubles (DDGS) or soyhulls/DDGS diet. Feed was offered as a meal through self-feeders and cattle were continually grazed at 5.6 hd/hectare on cool-season grasses that were predominantly fescue. As-fed daily intake averaged 10.5 kg/hd/d and 11.2 kg/hd/d, respectively, for each diet. Average daily gains (ADG) over the entire trial of the corn/DDGS diet were greater (1.59 kg/d vs. 1.52 kg/d,  $p = 0.09$ ) compared to the soyhulls/DDGS diet. Diets did not affect carcass traits of dressing percentage, yield grade or quality grade. As expected, implanted cattle gained faster (1.66 kg/d vs. 1.46 kg/d,  $p < 0.0001$ ) than non-implanted cattle. These faster gains resulted in heavier cattle coming off test (599.73 kg vs. 572.01 kg,  $p = 0.002$ ) and heavier hot carcass weights (374.7 kg vs. 360.0 kg,  $p = 0.02$ ). No differences were observed among implant treatments relative to marbling scores (1031.0 vs. 1016.0, non-implanted vs. implanted, respectively,  $p = 0.29$ ). However, percentage of cattle grading low choice or better was greater in non-implanted cattle (77.5% vs. 47.6%,  $p = 0.005$ ). This result was due to marbling score means being close to the break of high select and low choice quality grades. In conclusion, pasture rearing cattle, when given access to self-fed by-products, provides for excellent performance on both live and carcass traits. This system is an alternative to high-grain conventional beef finishing production.

**Key Words:** beef cattle, by-products, performance

**264 Effects of substituting wet distillers grains with solubles in a wet corn gluten feed based diet on finishing performance.** C. A. Nichols\*, M. K. Luebke<sup>1</sup>, G. E. Erickson<sup>1</sup>, R. A. Stock<sup>2</sup>, and T. J. Klopfenstein<sup>1</sup>, <sup>1</sup>*University of Nebraska, Lincoln*, <sup>2</sup>*Cargill, Blair, NE.*

A finishing study evaluated feeding a wet corn gluten feed (WCGF) based diet containing no corn with varying inclusions of wet distillers grains plus solubles (WDGS), as well as a control diet containing 20% WDGS and 20% WCGF. Three hundred and six steers ( $392 \pm 25$  kg) were used in a randomized complete block design to measure animal and carcass performance. Treatments consisted of different ratios of WCGF and WDGS 50:40, 60:30, 70:20, 80:10, 90:0 (DM basis) plus a control diet for a total of 6 treatments with 6 pens per treatment. All diets included 5% corn stalks and 5% supplement. Data were analyzed using Proc Mixed procedure of SAS and orthogonal polynomial contrasts were

used to evaluate response for WDGS levels. Intake increased linearly ( $P < 0.01$ ) as WDGS inclusion level decreased with 90:0 combination having the greatest DMI. A linear increase ( $P = 0.02$ ) was observed for G:F as WDGS inclusion level increased. Differences were not observed ( $P > 0.60$ ) across WDGS level for final BW. Both ADG and G:F were greater ( $P < 0.04$ ) for the control compared to all other treatments. The control treatment tended to have greater ( $P = 0.07$ ) marbling scores when compared to all other treatments. Fat depth, HCW, calculated YG and percentage USDA choice were unaffected by WDGS inclusion level. Dietary sulfur levels for this trial ranged from 0.34% for control diet to 0.56% for 50:40 treatment. As WDGS replaced WCGF, dietary sulfur levels increased. Two animals in the 50:40 treatment were diagnosed with sulfur induced polio. Byproduct based finishing rations will perform similar to a corn based ration that contains a combination of WCGF and WDGS. Due to the positive response in G:F, 40% WDGS inclusion level on a DM basis appears to be optimum; however, dietary sulfur may cause polio challenges with this diet.

**Key Words:** beef cattle, finishing performance, byproduct based diets

**265 Corn wet distillers grains plus solubles or solubles in feedlot diets containing wet corn gluten feed.** V. R. Bremer\*, J. R. Benton<sup>1</sup>, K. J. Hanford<sup>1</sup>, G. E. Erickson<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, and R. A. Stock<sup>2</sup>, <sup>1</sup>*University of Nebraska, Lincoln*, <sup>2</sup>*Cargill Wet Milling, Blair, NE.*

Two hundred seventy-nine crossbred steer calves (BW =  $446 \pm 26$  kg) were utilized in a 2x3 + 1 design to evaluate the effect of adding equal fat from corn wet distillers grains plus solubles (WDGS) or condensed corn distillers solubles (CCDS) to feedlot diets containing high moisture corn (HMC) and 35% wet corn gluten feed (WCGF) on cattle performance and carcass characteristics. Dietary treatments consisted of 35% WCGF with 0% WDGS or CCDS; 13.3, 26.7, or 40% WDGS; or 6.65, 13.35, or 20% CCDS replacing HMC in the diet (DM basis). All diets contained 5% ground cornstalks and 5% dry supplement. Steers were blocked by BW, stratified by BW within block, and assigned randomly to pen. Pens were assigned randomly to treatment within block with five pens/treatment and 8 steers/pen. Steers were fed for 82 d and slaughtered on d 83 at a commercial abattoir. Post trial lipid analysis indicated that fat addition from WDGS was greater than fat addition from CCDS. Therefore, performance of steers fed WDGS was analyzed independently from steers fed CCDS. Replacement of HMC with WDGS caused a linear decrease in ADG ( $P < 0.01$ ), a trend for linear decrease in DMI ( $P = 0.06$ ), and no change in G:F ( $P > 0.10$ ). When CCDS replaced HMC, no difference in steer performance was observed ( $P > 0.10$ ). Feeding WDGS or CCDS may effectively reduce the dietary inclusion of corn by at least 20% of diet DM in finishing diets containing 35% WCGF.

**Table 1.**

	Control	13.3 WDGS	26.7 WDGS	40 WDGS	6.7 CCDS	13.3 CCDS	20 CCDS
DMI, kg/d	10.42	10.28	10.29	9.55	10.28	10.01	10.23
ADG, kg	1.72	1.71	1.65	1.56	1.71	1.72	1.72
G:F	0.166	0.166	0.168	0.163	0.166	0.173	0.168
Fat, % of DM	4.1	5.0	5.9	6.9	4.8	5.5	6.2
Sulfur, % of DM	0.27	0.37	0.47	0.58	0.35	0.43	0.51

**Key Words:** distillers grains, distillers solubles, fat

**266 Effects of wet corn gluten feed and roughage inclusion levels in finishing diets containing modified distillers grains plus solubles.** J. R. Benton\*<sup>1</sup>, G. E. Erickson<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, M. K. Luebbe<sup>1</sup>, and R. U. Lindquist<sup>2</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Archer Daniels Midlands Co., Columbus, NE.

Four-hundred fifty steer calves (BW = 297 ± 20 kg) were used in a randomized complete block design to evaluate wet corn gluten feed (WCGF) and roughage inclusion level in finishing diets containing modified distillers grains plus solubles (MDGS). Treatments consisted of WCGF at 0, 15, or 30% inclusion and roughage at 0, 7.5, or 15% inclusion (DM basis) in a 3 × 3 factorial design. Corn silage was used as roughage and all diets contained 30% MDGS, 5% supplement (DM basis), and corn which was replaced as WCGF or roughage increased. There were no significant ( $P > 0.10$ ) WCGF × roughage level interactions observed. There was a quadratic response ( $P < 0.05$ ) for final BW, DMI, and ADG due to WCGF level which were lowest for cattle fed 30% WCGF. Final BW and ADG also responded quadratically ( $P < 0.05$ ) due to roughage level and were lowest for cattle fed 0% corn silage. Increasing roughage level resulted in a linear increase ( $P < 0.01$ ) in DMI. Gain:feed decreased linearly ( $P < 0.01$ ) with increasing WCGF levels and increasing roughage levels. In summary, feedlot performance was improved by feeding 0 or 15% WCGF compared to 30% WCGF in finishing diets containing 30% MDGS. The optimal roughage level using corn silage in finishing diets containing 30% MDGS with or without WCGF inclusion was 7.5% of diet DM.

**Table 1.**

Item	WCGF Inclusion Level, % DM			P-Linear	Value Quadratic
	0.0	15.0	30.0		
DMI, kg/d	10.1	10.2	10.0	0.15	0.04
ADG, kg/d	1.83	1.84	1.75	<0.01	<0.01
G:F, kg/kg	0.181	0.181	0.176	<0.01	0.13

  

Item	Roughage Inclusion Level, % DM			P-Linear	Value Quadratic
	0.0	7.5	15.0		
DMI, kg/d	9.6	10.1	10.6	<0.01	0.33
ADG, kg/d	1.74	1.83	1.85	<0.01	<0.01
G:F, kg/kg	0.182	0.181	0.174	<0.01	0.06

**Key Words:** finishing cattle, distillers grains, roughage

**267 Effects of concentration of alfalfa hay on performance of steers fed steam-flaked corn-based finishing diets containing 25% sorghum wet distiller's grains.** J. C. MacDonald\*<sup>1,2</sup>, K. H. Jenkins<sup>1</sup>, F. T. McCollum III<sup>3</sup>, and N. A. Cole<sup>4</sup>, <sup>1</sup>Texas AgriLife Research, Amarillo, <sup>2</sup>West Texas A&M University, Canyon, <sup>3</sup>Texas AgriLife Extension, Amarillo, <sup>4</sup>USDA-ARS, Bushland, TX.

Two hundred-forty crossbred yearling steers (379 ± 19 kg) were blocked by weight into a completely randomized design to determine effects of 25% wet sorghum based distiller's grains (WDG) in steam-flaked corn (SFC) based diets, and to determine effects of level of alfalfa hay (7.5, 10, and 12.5% DM; LOW, MED, HIGH, respectively) in diets containing 25% WDG on animal performance and carcass characteristics. A SFC-based control diet with 0% WDG and 10% alfalfa hay (CONT) was included to calculate the energy value of WDG. Contrasts included CONT vs. MED, and linear and quadratic effects of level of alfalfa hay

within WDG diets. Inclusion of WDG tended to increase DMI (10.4 vs. 10.9 kg for CONT and MED, respectively;  $P = 0.17$ ), reduce ADG (1.89 vs. 1.80 kg for CONT and MED, respectively;  $P = 0.15$ ), and significantly decreased gain:feed (0.181 vs. 0.166 for CONT and MED, respectively  $P = 0.03$ ) resulting in carcasses that tended to be lighter (418 vs. 410 kg for CONT and MED, respectively;  $P = 0.18$ ). The calculated energy density of the WDG was 73% the value of the SFC used in this study. Increasing the level of alfalfa hay in diets containing 25% sorghum WDG tended to linearly increase DMI (10.5, 10.9, and 11.0 kg for LOW, MED, and HIGH, respectively;  $P = 0.16$ ) and linearly decrease gain:feed (0.170, 0.166, and 0.161 for LOW, MED, and HIGH, respectively;  $P = 0.16$ ), with no change in ADG ( $P > 0.73$ ). Increasing alfalfa hay resulted in carcasses with linearly reduced fat thickness (1.65, 1.58, and 1.46 cm for LOW, MED, and HIGH, respectively;  $P = 0.03$ ), and a tendency for linearly reduced YG (3.37, 3.35, and 3.17 for LOW, MED, and HIGH, respectively;  $P = 0.17$ ) and linearly reduced dressing percentage (65.4, 65.1, and 64.2% for LOW, MED, and HIGH, respectively;  $P = 0.09$ ). While the inclusion of 25% sorghum WDG appears to dilute the energy density of the diet and may negatively impact animal performance, inclusion of roughage at a level equivalent to 7.5% alfalfa hay appears to be adequate in diets containing 25% sorghum WDG.

**Key Words:** wet distiller's grains, roughage level, animal performance

**268 Vaccination to reduce the prevalence of Escherichia coli O157:H7 in feedlot cattle fed wet distillers grains plus solubles.** A. R. Rich\*, A. N. Jepson, M. K. Luebbe, G. E. Erickson, T. K. Klopfenstein, D. R. Smith, and R. A. Moxley, University of Nebraska-Lincoln, Lincoln.

A trial was conducted to test vaccinating feedlot steers against Type III secretory proteins of E. coli O157:H7 on the proportion of steers shedding E. coli O157:H7 in feces when fed diets with or without corn wet distillers grains plus solubles (WDGS). Two blocks with a total of 480 crossbred steers (355 ± 18 kg) were assigned randomly to 60 pens (8 steers/pen) and pens were assigned randomly to one of four treatments in a 2 × 2 factorial design. Factors included vaccination treatment and dietary treatment. Dietary treatments consisted of a 3:2 ratio of high moisture (HMC) to dry rolled corn (DRC) or 40% WDGS replacing the 3:2 HMC:DRC (DM basis). The two blocks were started one week apart for sampling purposes. Steers were vaccinated three times at four week intervals beginning at trial initiation. Rectal fecal samples were collected 3, 6, 9, and 12 wks post vaccination. Fecal samples were cultured for E. coli O157:H7 using selective enrichment, immunomagnetic separation, and PCR confirmation. The probability for cattle to shed E. coli O157:H7 was modeled using multilevel logistic regression accounting for clustering of animals within pens and repeated measures of time. There was no interaction ( $P = 0.97$ ) between diet and vaccination for E. coli O157:H7 shedding. There was no interaction between treatment and sampling time ( $P > 0.40$ ) and no effect of time ( $P = 0.17$ ) on E. coli O157:H7 shedding. Vaccinated steers were 43% less likely to shed E. coli O157:H7 (odds ratio = 0.50;  $P < 0.01$ ) than non-vaccinated steers. Steers fed WDGS were 2.1 times more likely to shed E. coli O157:H7 than cattle fed the control diet (odds ratio = 2.5;  $P < 0.01$ ). These data suggest feeding WDGS increases feedlot cattle E. coli O157:H7 shedding when included at 40% of diet DM and vaccination decreases shedding.

**Key Words:** E. coli O157:H7, vaccination, wet distillers grains plus solubles

**269 Effect of bambermycins and level of distillers grains on performance and carcass characteristics of feedlot cattle.** E. R. Loe<sup>1</sup>, G. I. Crawford\*<sup>2</sup>, A. E. Wertz-Lutz<sup>1</sup>, and B. D. Rops<sup>1</sup>, <sup>1</sup>South Dakota State University, Brookings, <sup>2</sup>University of Minnesota, Hutchinson.

An experiment was conducted comparing medicated feed additives (MFA) bambermycins (Gainpro<sup>®</sup>, Huvepharma, Inc.) and monensin and tylosin (Rumensin<sup>®</sup> and Tylan<sup>®</sup>, Elanco Animal Health) in feedlot diets containing modified distillers grains (mDG). Steers (n = 256; initial BW 423 ± 27 kg) were allocated into 3 weight blocks in a randomized complete block design with a 2 x 2 factorial arrangement of treatments. The factors were: MFA (bambermycins at 20 mg/hd daily or monensin + tylosin at 380 and 90 mg/hd daily, respectively) and mDG inclusion (15 and 30% of diet DM). Twenty-four pens were utilized, resulting in 6 replications per treatment. Steers were fed a 1.39 Mcal/kg NEg diet consisting of a 1:1 combination of dry-rolled and high-moisture corn with the roughage portion of the diet consisting of corn silage and corn stover. Steers in the heaviest 2 blocks were marketed after 104 d and steers in the lightest block were marketed after 126 d. At d 28, d 87, and at final BW steers in the 30% mDG with monensin + tylosin treatment were lighter (P < 0.05) than all other treatments. Overall ADG tended (P = 0.08) to be greater with bambermycins than with monensin + tylosin, and was not affected (P = 0.16) by mDG level. Dry matter intake was lower (P < 0.05) with 30% mDG with monensin + tylosin than with any other treatment. Feed efficiency was not affected by mDG, MFA, or their interaction (P ≥ 0.34). Marbling scores were greater (P < 0.01) with bambermycins than with monensin + tylosin, and tended (P = 0.08) to be greater with 15% mDG than with 30% mDG. Carcasses from 30% mDG with bambermycins treatments had a greater percentage choice than 30% mDG with monensin + tylosin treatments (P < 0.05). Bambermycins produced more (P = 0.02) yield grade 4 carcasses than monensin + tylosin. Liver abscess occurrence was not affected (P ≥ 0.10) by mDG, MFA, or their interaction. Results from this experiment indicate that including bambermycins in feedlot diets containing 30% mDG results in increased DMI, final BW, and marbling score when compared with including monensin and tylosin in 30% mDG diets.

**Key Words:** bambermycins, distillers grains, feedlot steers

**270 35% corn wet distiller's grains plus solubles in steam-flaked and dry-rolled corn based finishing diets: Effects on animal performance.** J. C. MacDonald\*<sup>1,2</sup>, K. H. Jenkins<sup>1</sup>, E. K. Buttrey<sup>3,2</sup>, J. B. Lewis<sup>1,2</sup>, S. B. Smith<sup>4</sup>, R. K. Miller<sup>4</sup>, T. E. Lawrence<sup>2</sup>, F. T. McCollum III<sup>3</sup>, and N. A. Cole<sup>5</sup>, <sup>1</sup>Texas AgriLife Research, Amarillo, <sup>2</sup>West Texas A&M University, Canyon, <sup>3</sup>Texas AgriLife Extension, Amarillo, <sup>4</sup>Texas A&M University, College Station, <sup>5</sup>USDA-ARS, Bushland, TX.

Fifty-four crossbred steers (308 ± 8 kg) were fed dry-rolled corn (DRC) or steam-flaked corn (SFC) based finishing diets with and without 35% wet corn-based distiller's grains plus solubles (WDGS) to determine impacts of corn processing method and WDGS inclusion on animal performance and carcass characteristics. The WDGS replaced cottonseed meal, supplemental fat, urea, and corn (DRC or SFC). Steers were individually fed in a Calan-gate system for 174-d. Every 56-d, steers were ultrasonically scanned for backfat thickness and marbling, while jugular blood was collected and analyzed for blood glucose and blood urea nitrogen concentrations. Steers fed SFC-based diets consumed less feed (9.07 vs. 8.37 kg/d for DRC vs. SFC, respectively; P < 0.01) and had improved gain:feed (0.168 vs. 0.186 for DRC vs. SFC, respectively; P < 0.01) compared to steer consuming DRC-based diets. Steers consuming diets containing 35% WDGS had improved gain:feed (0.172 vs. 0.182

for 0% vs. 35% WDGS, respectively; P = 0.03) and produced carcasses with lower percent KPH fat (2.15 vs. 1.84% for 0% vs. 35% WDGS, respectively; P < 0.01) and loins with smaller longissimus area (86.3 vs. 82.3 cm<sup>2</sup> for 0% vs. 35% WDGS, respectively; P = 0.02). The calculated energy value of the WDGS was 103% the value of the SFC used in this study. Average blood glucose concentrations tended to be reduced by feeding SFC compared to DRC (78.2 vs. 75.8 mg/dl for DRC and SFC, respectively; P = 0.13) and were significantly reduced when feeding WDGS (79.1 vs. 74.9 mg/dl for 0% vs. 35% WDGS, respectively; P < 0.01). Blood urea nitrogen concentrations were greater in steers fed SFC than DRC-based diets (P < 0.01) and were greater in steers fed WDGS diets (P < 0.01). Serial ultrasound measurements indicated cattle consuming diets with WDGS deposit intramuscular fat at a reduced rate late in the feeding period. These data indicate that WDGS have energy values similar to SFC, but may impact carcass characteristics.

**Key Words:** wet distiller's grains plus solubles, corn processing, animal performance

**271 35% corn wet distiller's grains plus solubles in steam-flaked and dry-rolled based finishing diets: Effects on fatty acids, sensory attributes, and shelf life of loins.** J. C. MacDonald\*<sup>1,2</sup>, K. H. Jenkins<sup>1</sup>, E. K. Buttrey<sup>3,2</sup>, J. B. Lewis<sup>1,2</sup>, S. B. Smith<sup>4</sup>, R. K. Miller<sup>4</sup>, T. E. Lawrence<sup>2</sup>, F. T. McCollum III<sup>3</sup>, and N. A. Cole<sup>5</sup>, <sup>1</sup>Texas AgriLife Research, Amarillo, <sup>2</sup>West Texas A&M University, Canyon, <sup>3</sup>Texas AgriLife Extension, Amarillo, <sup>4</sup>Texas A&M University, College Station, <sup>5</sup>USDA-ARS, Bushland, TX.

Fifty-four crossbred steers (308 ± 8 kg) were fed dry-rolled corn (DRC) or steam-flaked corn (SFC) based finishing diets with or without 35% corn wet distiller's grain plus solubles (WDGS) to determine effects of corn processing method and WDGS inclusion on marbling attributes, sensory attributes, and shelf-life of beef loins. Subcutaneous adipose tissue was analyzed for enzyme activity and adipocyte size and volume. One loin per steer was purchased and cut into 2.54-cm-thick steaks. One steak was frozen and analyzed for fatty acid composition; one was vacuum packaged and aged for 14-d prior to freezing for sensory analysis using an expert, trained sensory panel. Five steaks were individually packaged in Styrofoam trays, over-wrapped and randomly assigned to 0, 1, 3, 5, or 7-d of aerobic storage at 2°C and analyzed for thiobarbituric acid reactive substances (TBARS) and instrumental color values. Although no difference was detected in visual marbling score, total fat content of steaks tended to increase with WDGS inclusion (P = 0.09). No differences in NADP-malate dehydrogenase, 6-phosphofructokinase activity, or intramuscular adipocyte volume or diameter due to WDGS inclusion were detected (P > 0.40). Ratio of monounsaturated:saturated fatty acids from longissimus muscle was strongly decreased (P < 0.01) by WDGS inclusion, likely due to a reduction in  $\Delta 9$  desaturase enzyme activity as indicated by a depression in the ratio of 16:1/18:0 fatty acids (P = 0.08). Differences in sensory attributes due to WDGS inclusion were statistically significant, but minimal in magnitude. Inclusion of WDGS into finishing diets increased lipid oxidation after five days of storage (P = 0.01) as measured by TBARS which resulted in steaks with reduced L\* values (P < 0.01). Feeding 35% WDGS in DRC or SFC-based finishing diets shifted fatty acids profiles toward increased saturated fatty acids and decreased color-life, but did not negatively impact intramuscular fat content and had consistent, but small impact on beef sensory and quality.

**Key Words:** wet distiller's grains plus solubles, finishing diets, beef quality

**272 Effects of sulfur and monensin concentrations on in vitro hydrogen sulfide production.** D. R. Smith<sup>1</sup>, N. DiLorenzo\*<sup>1</sup>, J. Leibovich<sup>1</sup>, M. L. May<sup>1</sup>, M. J. Quinn<sup>1</sup>, J. W. Homm<sup>2</sup>, and M. L. Galyean<sup>1</sup>, <sup>1</sup>Texas Tech University, Lubbock, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

Ruminally cannulated Jersey crossbred steers were used to evaluate effects of monensin (M) and S on in vitro H<sub>2</sub>S production. In Exp. 1, two steers were adapted (> 14 d) to a 75% concentrate diet (steam-flaked corn [SFC] base), and ruminal fluid was collected 4 h after feeding. Incubations (24 h) were conducted using a 3:1 ratio of McDougall's buffer:ruminal fluid. Substrate DM (approximately 0.7 g; 13.4% CP, 0.13% Ca, 0.29% P, and 0.14% S; comprised of 85.2% SFC, 9% alfalfa hay, 5% cottonseed meal, and 0.8% urea) was added to duplicate, 125-mL serum bottles to allow for gas collection. A Na<sub>2</sub>SO<sub>4</sub> solution was added to yield S equivalent to 0.2, 0.4, and 0.8% of substrate DM, and M was added at concentrations of 0, 2, 4, and 6 mg/L of culture volume. Head-space gas was analyzed for H<sub>2</sub>S by spectrophotometry using the *N-N*-dimethyl-*p*-phenylenediamine method. The 24-h IVDMD for each treatment was determined in duplicate, 50-mL tubes. Incubations were replicated on 3 separate days, and data were analyzed as a randomized complete block design with a 3 (S) × 4 (M) factorial arrangement of treatments. No effects of M ( $P = 0.29$ ) or of the M × S interaction ( $P = 0.41$ ) were detected for H<sub>2</sub>S production. Increasing S linearly increased ( $P < 0.01$ ) H<sub>2</sub>S production (mmoles/g of fermentable DM). The IVDMD (average 70.0%) was not affected by M ( $P = 0.93$ ), S ( $P = 0.18$ ), or the M × S interaction ( $P = 0.56$ ). In Exp. 2, two steers were adapted (> 21 d) to a 75% concentrate diet (SFC base) that contained 15% wet corn distillers grains with solubles (WDGS) and monensin at 22 mg/kg (DM basis). Substrate DM (13.3% CP, 0.14% Ca, 0.33% P, and 0.20% S) was comprised of 75.4% SFC, 15% WDGS, 9% alfalfa hay, and 0.6% urea. Procedures, treatments, and statistical analyses were as in Exp. 1. No effects of M ( $P = 0.93$ ) or of the M × S interaction ( $P = 0.99$ ) were noted for H<sub>2</sub>S production; however, increasing S linearly increased ( $P < 0.01$ ) H<sub>2</sub>S production. No effects of M ( $P = 0.16$ ), S ( $P = 0.43$ ), or the M × S interaction ( $P = 0.10$ ) were noted for IVDMD (average 70.9%). Increasing S concentration increased in vitro H<sub>2</sub>S production, but monensin was without effect.

**Key Words:** sulfur, hydrogen sulfide, ionophores

**273 Feedlot incidences of polio and ruminal hydrogen sulfide levels with varying hay level inclusion.** S. Vanness\*, N. Meyer, T. Klopfenstein, and G. Erickson, *University of Nebraska, Lincoln.*

Data were compiled from 4143 cattle on byproduct feeding experiments. Incidence of polioencephalomalacia was small (0.14% or 3/2147) in diets containing 0.46% S or less. Incidences increased as cattle were fed diets above 0.46% S (3/566) and especially above 0.56% (6/99). The objective was to determine if ruminal pH impacts H<sub>2</sub>S concentration in the rumen by changing grass hay levels in finishing diets. In Exp. 1, 7 ruminally cannulated steers (BW = 301.8 kg) were adapted with 3 adaptation diets and a common finisher all containing 50% DM wet distillers grains plus solubles (WDGS) with 0.50, 0.48, 0.46 and 0.44% S, respectively. Alfalfa was decreased in these diets from 35, 25, 15, and 7.5% for diets 1, 2, 3 and finisher, respectively. All periods were 7 d long with collection on d 7. Hydrogen sulfide levels increased as roughage decreased throughout the adaptation diets at both 8 and 23 h post feeding. Hydrogen sulfide levels at 8 h were 8.90, 8.30, 47.7, 121.5 μmol/ml of rumen gas for diets 1, 2, 3 and the finisher respectively ( $P < 0.01$ ). Average pH was significantly different with 6.05, 5.51, 5.49, and 5.51 for diets 1, 2, 3, and finisher, respectively ( $P < 0.01$ ). In Exp.

2, 7 ruminally cannulated steers were used in a 6×6 Latin square. The two treatment factors were byproducts and grass hay level. The diets were: 50% WDGS with 0, 7.5 and 15% grass hay (DMB) 0.43, 0.42 and 0.41% S respectively; and 37.5% WDGS/37.5% wet corn gluten feed (WCGF) with 0, 7.5 and 15% grass hay (DMB) 0.47, 0.46, and 0.45% S, respectively. Each diet was fed for 7 d with H<sub>2</sub>S samples collected at 8 and 23 h post feeding on d 7. There was no byproduct by grass hay level interaction. At 8 h, H<sub>2</sub>S levels declined linearly as grass hay levels increased 125.9, 55.9 and 29.7 μmol/ml, for 0, 7.5, and 15% grass hay, respectively ( $P < 0.01$ ). Fiber content in byproducts make it tempting to remove roughage from cattle diets, however removing all roughage increases H<sub>2</sub>S concentration in the rumen and presumably the risk of polioencephalomalacia.

**Key Words:** feedlot, hydrogen sulfide, polioencephalomalacia

**274 Measuring the bacterial protein of rumen fluid using real time polymerase chain reaction (RTPCR).** E. Castillo-Lopez\*, J. Miner, and P. Kononoff, *University of Nebraska, Lincoln.*

The objective of this research is to develop an assay that can estimate bacterial crude protein content of rumen fluid and that is not confounded by yeast contained in certain feedstuffs. Rumen fluid was collected from two steers over a five day period. A bacterial pellet was then isolated by differential centrifugation for N assay and DNA extraction. The ten DNA samples were assayed by RTPCR on each of 4 d. The data were analyzed as a factorial 2x5x4 completely randomized design. The ratio (R) of bacterial DNA (absolute abundance: AA) to bacterial crude protein (BCP) was  $2.6 \pm 0.13$  ( $R = AA/g \text{ BCP}$ ) and this was influenced by RTPCR run ( $P < 0.05$ ) and collection day ( $P < 0.01$ ), but not animal ( $P > 0.1$ ). We evaluated the utility of using this method by measuring BCP in an independent experiment. Two ruminal digesta samples were collected and analyzed in quadruplicate in three ways. The first measurement was of a bacterial pellet using a nitrogen analyzer; the second was also of a bacterial pellet, but using the estimate of R and RTPCR; and the third was of a crude pellet of total digesta using the estimate of R and RTPCR. The resulting estimates of BCP were: 0.27 g/l digesta (SEM = 0.02), 0.18 g/l digesta (SEM = 0.02) and 0.34 g/l digesta (SEM = 0.02), respectively. These estimates differed ( $P < 0.01$ ). The lower estimate of BCP based on RTPCR as compared to nitrogen analyzer is perhaps due to an overestimate of R. A broad survey of how R is influenced by relevant factors will be needed before the reliability of this approach can be fully determined. The higher estimate of BCP in the crude pellet is likely due to more bacteria in the pellet. We assume significant numbers of bacteria were removed from the first two treatments during the differential centrifugation to obtain a purely bacterial pellet. Considering our data, we propose that an RTPCR-based approach may be an effective means to distinguish BCP from feed protein, particularly when diets containing yeast cells are fed.

**Key Words:** absolute abundance, bacterial crude protein, bacterial DNA

**279 Effects of supplemental organic cobalt on nutrient digestion and nitrogen balance in lambs fed forage-based diets.** E. J. Scholljegerdes\*<sup>1</sup>, W. J. Hill<sup>2</sup>, and H. T. Purvis<sup>2</sup>, <sup>1</sup>USDA-ARS, Northern Great Plains Research Laboratory, Mandan, ND, <sup>2</sup>Ralco Nutrition Inc., Marshall, MN.

The objective of this study was to determine the effects of supplemental organic cobalt on nutrient digestion and nitrogen balance in lambs fed forage-based diets. Sixteen wether lambs (avg initial BW =  $28.6 \pm 1.3$

kg) were used in a 2 × 2 Latin square and randomly allotted to one of two treatments being ad libitum grass hay (7.1% CP 67.9% NDF, DM basis) plus 45.0 g (as fed) dried distillers grains with mineral formulated to provide 1.1 mg•hd<sup>-1</sup>•d<sup>-1</sup> of Cobalt (**CONTROL**) or mineral plus CoMax 100™ formulated to provide 7.1 mg•hd<sup>-1</sup>•d<sup>-1</sup> of Cobalt (**COBALT**). Experimental periods were 21 d in length and consisted of 15 d for diet adaptation and 6 d of total fecal and urine collection. Forage DM intake increased ( $P = 0.091$ ) when lambs consumed COBALT. Likewise, forage OM and NDF intake also increased with COBALT ( $P \leq 0.086$ ). Despite the increase in forage intake, fecal DM, OM, and NDF flow ( $P \geq 0.654$ ) did not differ across treatment. Due to the increase in intake of DM, OM, and NDF, and no differences being observed for fecal flow, DM, OM, and NDF digested (g/d) was greater for COBALT ( $P \leq 0.098$ ) than CONTROL. Nevertheless, total tract DM, OM, and NDF digestibility (% of total intake) did not differ ( $P \geq 0.591$ ) when additional cobalt was provided to lambs. No differences were observed between treatments for total N intake ( $P = 0.129$ ), total tract N digested (g/d) ( $P = 0.135$ ), or urine N output ( $P = 0.812$ ) and consequently, differences were not expected for total N output ( $P = 0.782$ ). The provision of additional cobalt to lambs did not increase ( $P = 0.251$ ) N retention (g/d). Likewise, treatment did not affect N retention when expressed as a % of intake ( $P = 0.82$ ) or as a % of N digested ( $P = 0.95$ ). In conclusion, providing growing lambs consuming a forage-based diet 7.1 mg•hd<sup>-1</sup>•d<sup>-1</sup> of Cobalt did increase forage intake but did not affect total tract digestibility or N balance.

**Key Words:** cobalt, lamb, digestion

**280 Effects of nutritional plane and selenium supply during gestation on ewe performance, body composition, and offspring body weight.** A. M. Meyer<sup>\*1</sup>, J. J. Reed<sup>1</sup>, D. J. Newman<sup>1</sup>, J. B. Taylor<sup>2</sup>, L. P. Reynolds<sup>1</sup>, D. A. Redmer<sup>1</sup>, K. A. Vonnahme<sup>1</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

To investigate effects of nutritional plane and Se supply during gestation on ewe and offspring performance, 84 Rambouillet ewe lambs (age = 240 ± 17 d, BW = 52.1 ± 6.2 kg), were allocated to a 2 × 3 factorial design. Factors included Se (adequate Se [ASe, 8.5 µg/kg BW] or high Se [HSe, 80 µg/kg BW]) initiated at breeding and nutritional plane (60% [RES], 100% [CON], and 140% [HIGH] of NRC requirements) initiated at d 40 of gestation. Ewes were fed and housed individually in a temperature-controlled facility. At parturition, lambs were removed and artificially reared, and 42 ewes (7/treatment) were necropsied. Remaining ewes were transitioned to common diets with 100% requirements and were mechanically milked until necropsy on d 20. From d 95 of gestation through parturition and d 20 of lactation, ewe BW and BCS were least ( $P \leq 0.01$ ) in RES, intermediate in CON, and greatest in HIGH. Ewes fed HSe had greater ( $P \leq 0.05$ ) BCS than ASe from d 95 through lambing. During gestation, RES had the least ( $P < 0.001$ ) ADG, followed by CON, and HIGH had the greatest (-11 vs. 97 vs. 194 g/d), whereas HSe had greater ( $P < 0.001$ ) ADG than ASe (106 vs. 81 g/d). Ewe backfat (BF) and LM area (LMA) on d 135 of gestation were least ( $P < 0.001$ ) in RES, intermediate in CON, and greatest in HIGH (0.40 vs. 0.53 vs. 0.75 cm BF; 9.1 vs. 11.6 vs. 13.9 cm<sup>2</sup> LMA), with HSe having greater ( $P \leq 0.03$ ) BF than ASe (0.53 vs. 0.59 cm). Ewe ADG was not different during 20 d of lactation, but RES increased ( $P = 0.02$ ) LMA compared with a decrease in HIGH. Necropsy period had no effect on ewe omental and mesenteric fat or perirenal fat weights, although both were greater ( $P < 0.001$ ) in HIGH than RES and CON. Ewe nutritional plane tended ( $P = 0.11$ ) to effect lamb birth weight, with lambs from RES ewes being lighter than CON and HIGH. On d 7, lambs from RES

ewes had lower ( $P < 0.05$ ) BW than CON and HIGH, which continued through d 19 (9.3 vs. 10.5 and 10.6 kg). Results indicate that BW differences in pregnant ewes due to gestational nutrition are accompanied by changes in body composition and offspring BW, both of which may be impacted by Se supply.

**Key Words:** gestation, growth, nutrition

**281 Conception rates of beef cows fed a supplement with rumen-protected fat.** P. Moriel<sup>\*1</sup>, E. Pegorer Goncalves<sup>1</sup>, V. Nayigihugu<sup>1</sup>, G. Aines<sup>2</sup>, E. Block<sup>2</sup>, and B. Hess<sup>1</sup>, <sup>1</sup>University of Wyoming, Laramie, <sup>2</sup>ARM & HAMMER Animal Nutrition, Division of Church & Dwight Co., Inc., US.

The objective of this experiment was to evaluate conception rate in postpartum beef cows supplemented with rumen-protected fat. Primiparous (n = 45) and multiparous (n = 57) lactating beef cows (initial BW = 519 ± 6 kg) were synchronized (CO-Synch) with an intravaginal progesterone device + injection of 2 mL (100 µg; i.m) of GnRH on day 0. At which time cows were randomly assigned to one of two dietary treatments (each age groups served as a block): The Control groups were fed a beet pulp-based supplement at 1.77 kg.cow-1.d-1 whereas fat supplemented cows were offered a beet pulp-based hand-fed supplement containing rumen-protected fat (1.36 kg/d), formulated to deliver Megalac-R<sup>®</sup> at 250 g.cow-1.d-1 (estimated to provide between 34 to 41 g/d of 18:2n-6). Supplements were formulated to provide equal quantities of protein and energy. Cows had free access to bromegrass hay (% of DM: 66.5% NDF, 43.9% ADF, 0.97% N, 50.0% IVDMD) throughout the synchronizing period (day 0 until the day of insemination). On day 7, the intravaginal progesterone device was removed and 5 ml (25 mg; i.m) of prostaglandin was administered. Sixty six hours later a 2 ml (100 µg; i.m) injection of GnRH was administered, cows were inseminated and transported to native pasture (% of DM: 53.8% NDF, 30.1% ADF, 2% N, 59.0% IVDMD) where they remained on their respective dietary treatments for 30 days. Blood samples were obtained 30 days after breeding for pregnancy diagnosis. Data were analyzed as randomized complete block design. Body weight gain did not differ ( $P = 0.54$ ) between treatments. First conception rate was not affected ( $P = 0.84$ ) by dietary treatments, with Control having a conception rate of 50.9% and cows fed supplemental lipid having a conception rate of 47.2%. Rumen-protected fat can be utilized as a supplement for postpartum beef cows if it is economically feasible compared to other energy sources.

**Key Words:** fat supplementation, conception rate, beef cows

**286 Utilization of leaf litter as a potential feed source.** J. K. Smith<sup>\*1</sup>, J. Neel<sup>2</sup>, and E. E. D. Felton<sup>1</sup>, <sup>1</sup>West Virginia University, Morgantown, <sup>2</sup>Appalachian Farming Systems Research Center, Beaver, WV.

Proximate analysis and In-situ nylon bag ruminal dry matter degradation of fall dropped *Liriodendron tulipifera* (tulip poplar) and *Quercus alba* (white oak) leaves were used to determine their potential use as a feed source for ruminant livestock animals. Ash content was 8.24 and 4.69 percent, respectively. Crude protein, as determined by the Kjeldahl procedure, was 6.81 and 5.99 percent for poplar and oak, of which 5.63 and 4.72 percent was soluble, respectively. Neutral detergent fiber, acid detergent fiber, and acid detergent lignin of poplar leaves was 36.25, 25.18, and 6.15 percent, respectively. With the poplar leaves, 1.82 percent of the CP was bound to the NDF fraction, and 0.95 percent was bound to the ADF fraction. Neutral detergent fiber, acid detergent fiber,

and acid detergent lignin of oak leaves were 39.93, 30.23, and 8.89 percent, respectively. Similar to poplar, 1.36 percent of the CP in the oak leaves was bound to the NDF fraction, and 0.99 percent was bound to the ADF fraction. Ether extract was found to be 4.51 and 4.66 percent for poplar and oak, respectively. Ruminal dry matter digestibility at 0, 1, 2, 4, 8, 12, 24, 48, and 72 hours was determined in triplicate via a switch back design in the rumen of two lactating dairy cows fed a corn silage/grass haylage based diet. In-situ DMD differed ( $p < 0.001$ ) for each leaf species at each of the respective time points. Dry matter digestibility of poplar and oak leaves was 24.86 vs. 22.57, 26.66 vs. 23.61, 28.44 vs. 24.38, 31.15 vs. 24.13, 36.61 vs. 27.15, 47.91 vs. 30.51, 57.90 vs. 40.74, 65.59 vs. 46.89, and 68.45 vs. 49.29 percent at the respective hours. Dry matter digestibility of poplar and oak leaves appear to have similar ( $p < 0.05$ ) rates of digestion up to approximately 4 hours of digestion, with poplar having an increased ( $p < 0.05$ ) rate of digestion at time points after 4 hours of incubation. Further examination is necessary to determine potential incorporation in complete diets.

**Key Words:** leaf litter, ruminants, alternative feeds

**287 Relationship between mitochondrial complex proteins and RFI in steers.** M. P. Davis\*, M. A. Brooks, J. H. Porter, and M. S. Kerley, *University of Missouri, Columbia*.

The objective of this study was to determine the relationship between mitochondrial complex I, II, and III protein concentrations in lymphocytes and residual feed intake (RFI) in steers. Individual feed intake (FI) was recorded for 88 Hereford crossbred steers over 63 d. Residual feed intake was computed as the residual of actual FI minus expected FI. Lymphocytes were isolated from efficient steers ( $RFI \approx -1.32 \pm 0.13$  kg/d,  $n \approx 10$ ) and inefficient steers ( $RFI \approx -1.34 \pm 0.15$  kg/d,  $n \approx 8$ ). Immunocapture of mitochondrial complex I, II and III proteins from the lymphocyte was done using the MitoProfile complex I, II, and III proteins Immunocapture kit (Mitosciences, Eugene, OR). Concentrations of complex I, II, III, and total protein were quantified using bicinchoninic acid colorimetric procedures. High RFI steers consumed 3.52 kg more ( $P \leq 0.05$ ) feed and had a lower ( $P \leq 0.05$ ) gain to feed (G:F) compared to low RFI steers. The initial body weight, final body weight and ADG during the RFI test period was not correlated ( $P \geq 0.15$ ) to RFI and was similar ( $P \geq 0.15$ ) between low and high RFI steers. Complex I concentrations tended to be correlated ( $P \approx 0.15$ ) with RFI ( $R \approx -0.35$ ). Ratios of complex I to II and complex I to III were correlated ( $P \leq 0.05$ ) with RFI ( $R \approx -0.54$  and  $-0.67$ , respectively) and tended ( $P \leq 0.15$ ) to be correlated with G:F ( $R \approx 0.39$  and  $0.45$ , respectively) and FI ( $R \approx -0.44$  and  $-0.41$  respectively) but not ( $P \geq 0.15$ ) ADG. Regression models of complex ratios I to II and I to III were significant ( $P \leq 0.05$ ) for RFI ( $R \approx 0.45$ ) but not significant ( $P \geq 0.15$ ) for G:F. The greater ratio of complex I proteins to complex III proteins in efficient animals could allow more rapid shuttling of NADH into the mitochondria and return to phosphorylation potential homeostasis, which in turn would result in satiety being reached at lower caloric intake than inefficient animals.

**Key Words:** residual feed intake, mitochondrial complex protein, crossbred steers

**288 Effect of length of time between maternal separation and shipping on feedlot performance and carcass merit of ranch-direct beef calves weaned during the summer.** J. W. Bolte\*<sup>1</sup>, J. R. Jaeger<sup>1</sup>, T. B. Schmidt<sup>2</sup>, D. U. Thomson<sup>1</sup>, B. J. White<sup>1</sup>, R. L. Larson<sup>1</sup>, G. A. Milliken<sup>1</sup>, N. A. Sproul<sup>1</sup>, M. D. Thomas<sup>1</sup>, and K. C. Olson<sup>1</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*Mississippi State University, Starkville*.

Ranch-of-origin weaning periods of between 30 and 60 d are suggested for preconditioning beef calves prior to sale. Our objective was to test the validity of these suggestions for ranch-direct calves aged 100 to 160 d and weaned during the summer. Angus  $\times$  calves ( $n = 408$ ) were stratified by age and assigned randomly to 1 of 5 weaning periods that corresponded to the length of time between separation from the dam and shipping to an auction market: -60, -45, -30, -15, or 0 days. Calves were vaccinated against common diseases 14 d before maternal separation and again on the day of maternal separation. On a common shipping date (d 0; August 24), calves were transported 3 h to a commercial auction market and held for 14 h. Calves were then transported 1 h to a feedlot. All calves were fed the same diet ad libitum and monitored daily for symptoms of respiratory disease. Calves were fed to reach an average endpoint of 10 mm of backfat at the 12th rib and harvested in three groups. Calf BW at receiving tended to decrease linearly ( $P = 0.06$ ) with successively earlier weaning dates; however, calf BW was similar ( $P > 0.2$ ) between treatments from d 30 after feedlot arrival to harvest. Intake of DM during the first 30 d following feedlot receiving increased linearly ( $P > 0.01$ ) as the length of the ranch-of-origin weaning period increased; however, DM intake was similar ( $P > 0.3$ ) between treatments from d 30 to harvest. Calf ADG and G:F were also similar ( $P > 0.2$ ) between treatments from d 30 to harvest. Days on feed tended to increase linearly ( $P = 0.06$ ) with successively longer weaning periods. Dressing percentage, 12th-rib fat thickness, HCW, KPH, marbling, longissimus area, and YG were similar ( $P > 0.2$ ) between treatments. Liver and lung scores were similar ( $P > 0.3$ ) between treatments. For ranch-direct calves weaned during the summer, ranch-of-origin weaning periods of between 15 and 60 d did not affect finishing performance beyond the first 30 d in the feedlot and did not affect carcass merit relative to shipping calves immediately after maternal separation.

**Key Words:** preconditioning, weaning, carcass merit

**289 Post-wean performance by spring and fall-born steer calves weaned from full access, limited access, or no access to endophyte-infected tall fescue.** J. Caldwell\*<sup>1</sup>, K. Coffey<sup>1</sup>, D. Philipp<sup>1</sup>, J. Jennings<sup>3</sup>, D. Hubbell, III<sup>1</sup>, T. Hess<sup>1</sup>, D. Kreider<sup>1</sup>, M. Looper<sup>2</sup>, M. Popp<sup>1</sup>, M. Savin<sup>1</sup>, and C. Rosenkrans, Jr.<sup>1</sup>, <sup>1</sup>*University of Arkansas, Fayetteville*, <sup>2</sup>*USDA-ARS, Booneville, AR*, <sup>3</sup>*Cooperative Extension Service, Little Rock, AR*.

Replacing Neotyphodium coenophialum-infected tall fescue (E+) with non-toxic endophyte-infected fescue (NE+) may improve calf weaning BW (WW), but those impacts on post-weaning performance and carcass traits have not been reported. Our objective was to compare post-weaning performance by spring (S) and fall-born calves (F) weaned from cows grazing either E+ or NE+ at different percentages of the total pasture area to determine to what extent having limited access to NE+ prior to weaning will affect post-weaning performance. Gelbvieh  $\times$  Angus crossbred cows ( $n = 144$ ,  $518 \pm 5.8$  kg initial BW; resulting in 83 steer calves) were stratified by weight and age within calving season and allocated randomly to 1 of 14 groups representing 5 treatments: 1)

F on 100% E+ (F100); 2) S on 100% E+ (S100); 3) F on 75% E+ and 25% NE+ (F75); 4) S on 75% E+ and 25% NE+ (S75); and 5) S on 100% NE+ (NE100; 2 replications). Sire effects were detected ( $P < 0.05$ ) for hot carcass weight, WW, and BW at shipping and at the end of the feedlot phase. Adjusted and actual WW were greater ( $P < 0.01$ ) from F vs. S, but BW at shipping was greater ( $P < 0.01$ ) and feedlot ADG tended to be greater ( $P = 0.10$ ) from S vs. F. Adjusted WW was greater ( $P < 0.05$ ) and WW and shipping BW tended to be greater ( $P < 0.10$ ) from S75 and F75 vs. S100 and F100. A calving season by %NE+ interaction affected ( $P < 0.05$ ) adjusted WW, shipping and final BW, hot carcass weight, and yield grade. Therefore, fall calving may benefit steer WW but these effects may not persist through the feedlot phase. Limited use of NE+ may enhance performance by spring-born steers to a greater extent than fall-born steers. This project was supported by the National Research Initiative of the Cooperative State Research, Education and Extension Service, USDA, grant # 2006-55618-17114.

**Key Words:** calves, novel endophyte, tall fescue

**291 Effects of functional oils and monensin alone or in combination on feedlot cattle growth and carcass composition.** M. Jedlicka<sup>1</sup>, T. Purevjav<sup>1</sup>, A. Conover<sup>1</sup>, J. Torrent<sup>2</sup>, G. Pusillo<sup>2</sup>, and M. Hoffman<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Oligo Basics USA LLC, Wilmington, DE.

Functional oils, natural products, have been introduced into the United States because they are thought to offer similar benefits as ionophores without the drawbacks of synthetic products. This study consisted of a commercial mixture of functional oils (Essential, Oligo Basics USA LLC, Wilmington, DE), composed of cashew nut shell oil and castor oil, used alone and in combination with monensin to evaluate the effects on steers performance when fed a high concentrate diet. One hundred and twenty steers (average initial weight 322 kg) were divided into five treatments with four replications and six animals in each replication. Treatments were control (C), monensin (223 mg.hd.-d-) (M), monensin (223 mg.hd.-d-) + Essential (250 mg/kg DMI) (ME), Essential Low (250 mg of Essential/kg DMI) (EL) and Essential High (500 mg of Essential/kg DMI) (EH). All steers were fed the same diet (0.29 Mcal of NE/g kg DM, 0.41 Mcal of NEm/kg DM) on an ad libitum basis, treatments M and EL for 172 days and treatments C, ME, and EH for 179 days. Average daily gain was higher ( $P < 0.05$ ) and F:G ratio was lower ( $P < 0.05$ ) for the M treatment when compared to the EH but not significantly different to the other treatments. However, neither hot carcass weight, nor carcass efficiency, calculated as kg of DMI divided by hot carcass weight, were different among treatments. Dressing percent was lower for the M and EL treatments when compared to ME and EH (60.2%, 60.2%, 62.2% and 62.2%, respectively,  $P < 0.05$ ). The C treatment (61.2%) was not significantly different from any other treatments. Quality grades (1 = low select; 9 = high prime) for C, ME and EL treatments were, 3.46, 3.50 and 3.54, respectively, and were higher ( $P < 0.05$ ) than the M treatment and lower ( $P < 0.05$ ) than the EH treatment (3.18 and 4.04, respectively). There were no differences in loin eye area, backfat, KPH, or yield grade between treatments. When comparing EH to M, F:G was higher, however, carcass weights and efficiencies were not different. Functional oils also increased quality grade without affecting any other carcass characteristics.

**Key Words:** functional oils, feedlot performance, carcass composition

**292 Effects of fat enriched protein supplement on performance and tissue fatty acid composition of grazed lambs.** Q. Baptiste\*, S. Chavez, E. Nestor, D. Matapadrino, and E. Felton, *West Virginia University, Morgantown.*

The effects of fat (F), protein (PR), and fat enriched protein (FP) supplements on performance and tissue fatty acid composition of grazed lambs were investigated. Lambs (33) were blocked by sex and weight ( $19.71 \pm 1.74$  kg) and randomly allocated to receive one of three supplements offered at 10 (F and PR), and 13% (FP) of estimated daily dry matter intake. Supplements PR and FP were soybean meal: soybean hull (1:1) and F was soybean hull with 0, 23 or 30 % added soybean oil. All supplements were offered at 01600 for the final 29 d of an 81 day stay on mixed pastures and then for a further 39 d finishing in drylots. During this latter period lambs were fed orchard grass and alfalfa hay (1:1 ratio) along with the ascribed supplement. Herbage mass and growth rate, pasture quality and accessibility were similar ( $P > 0.05$ ) across treatments. The percentages of offered daily supplement (F = 88.63, PR = 81.01, FP = 88.14  $\pm$  2.42 %) and hay (F = 81.92, PR = 85.10, FP = 82.14  $\pm$  0.79 %) consumed, differed ( $P < 0.05$ ) across treatments. Grazing activity of each treatment flock prior to (F = 82.82, PR = 45.45, FP = 0.00  $\pm$  12.50 %) and after (F = 36.36, PR = 0.00, FP = 0.00  $\pm$  8.78 %) supplementation differed ( $P < 0.05$ ). Daily gains of lambs after supplementation while on pasture (F = 0.30, PR = 0.22, FP = 0.27  $\pm$  0.02 kg/d) tended to differ ( $P = 0.05$ ). During the first 2 weeks in the drylot, ADG differed ( $P < 0.01$ ) amongst treatments (F = -0.05, PR = 0.23, FP = 0.11  $\pm$  0.05 kg/d). Overall, ADG of lambs, and HCW of slaughtered wether lambs were similar ( $P > 0.05$ ) across treatments, but dressing percentage tended to be higher ( $P = 0.08$ ) in PR than in F and FP (46.62, 44.27 and 43.85  $\pm$  0.76 %) wethers. The SFA to unsaturated fatty acids ratio of muscle was lower ( $P = 0.02$ ) in the F than in FP and PR treatments (0.98 vs 1.38 and 1.22  $\pm$  0.07) and kidney PUFA: SFA was lowest ( $P = 0.04$ ) in PR vs F and FP (0.05, 0.08 and 0.10  $\pm$  0.01) respectively. Lamb management strategy, especially delayed supplementation influenced grazing activity, forage intake, lamb growth and fatty acid profile of tissues.

**Key Words:** fat supplementation, grazing lamb performance, tissue fatty acids profile

**293 Influence of dietary thiamin supplementation on ruminal pH and hydrogen sulfide gas concentration in lambs fed a ration containing 60% distillers dried grains with solubles.** B. W. Neville<sup>1</sup>, C. S. Schauer<sup>2</sup>, L. A. Kirschten<sup>1</sup>, K. Karges<sup>3</sup>, M. L. Gibson<sup>3</sup>, and G. P. Lardy<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Hettinger Research and Extension Center, Hettinger, ND, <sup>3</sup>Dakota Gold Research Association, Sioux Falls, SD.

The objective of this study was to evaluate the effect of increasing level of thiamin supplementation on ruminal gas cap hydrogen sulfide (H<sub>2</sub>S) concentration and pH in lambs. Twenty crossbred lambs (38.4  $\pm$  3.2 kg) were adapted over 31 d to a finishing diet consisting of (DM basis) 60% distillers dried grains with solubles, 21.4% corn, 15% alfalfa hay, and 3.6% supplement (ammonium chloride, limestone, trace minerals, lasalocid, copper sulfate, and thiamin). Treatments were based on 4 levels of thiamin supplementation and contained 0.7% S: 1) CON (no supplemental thiamin), 2) LOW (50 mg•hd<sup>-1</sup>•d<sup>-1</sup>), 3) MED (100 mg•hd<sup>-1</sup>•d<sup>-1</sup>), 4) HIGH (150 mg•hd<sup>-1</sup>•d<sup>-1</sup>). A fifth treatment was formulated to contain 0.8% S (through addition of sulfuric acid) with 150 mg•hd<sup>-1</sup>•d<sup>-1</sup> thiamin (HIGH+S). Hydrogen sulfide and rumen fluid pH were collected via rumen puncture on d -6, -3, 0, 3, 7, 10, 14, 17, 21, 24, 28, and 31 (d 0 signifies the d dietary adaptation began). Data were

analyzed utilizing a repeated measures analysis in the Mixed Procedures of SAS with  $P$ -values  $< 0.10$  considered significant. No differences in  $H_2S$  concentration ( $P > 0.10$ ) between treatments were apparent until d 10, at which point lambs fed LOW had lower  $H_2S$  concentrations than all other treatments. Lambs fed HIGH had the greatest concentrations of  $H_2S$  on d 31 (7729 ppm  $H_2S$ ;  $P < 0.009$ ). Ruminal pH for lambs fed CON and MED were not different from d 0 throughout sampling ( $P > 0.18$ ). Ruminal pH of LOW, HIGH, and HIGH+S groups decreased ( $P < 0.03$ ) over time. Thiamin appears to influence ruminal  $H_2S$  concentrations, although the mechanism by which this occurred remains unknown. Changes in  $H_2S$  concentration cannot be attributed solely to ruminal pH, and are likely affected by multiple factors which interact within the ruminal environment and in the animal.

**Key Words:** distillers dried grains, hydrogen sulfide, thiamin

**294 Effects of distillers dried grains with solubles inclusion in growing and finishing diets on intake, average daily gain, and gain efficiency of beef steers.** J. L. Leupp<sup>\*1</sup>, G. P. Lardy<sup>1</sup>, R. J. Maddock<sup>1</sup>, M. L. Bauer<sup>1</sup>, K. Karges<sup>2</sup>, M. L. Gibson<sup>2</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>*North Dakota State University, Fargo*, <sup>2</sup>*Dakota Gold Research Association, Sioux Falls, SD*.

Seventy-two beef steers ( $296 \pm 9$  kg initial BW) were blocked by weight and used in a randomized complete block design with treatments arranged as a  $2 \times 2$  factorial to determine effects of distillers dried grains with solubles (DDGS) on growing and finishing steer intake, ADG, and G:F. Main effects were feeding period (growing or finishing) and DDGS inclusion (0% or 30%; DM basis; partially replacing corn) resulting in 4 treatments: 0%:0%, 30%:0%, 0%:30%, and 30%:30% (percentages are proportion of DDGS fed during growing and finishing periods, respectively). Steers were fed individually throughout the study. Steers were fed a growing diet (65% concentrate) for 57 d then gradually acclimated to a finishing diet (90% concentrate) for 82 or 143 d. Diets were based on dry rolled corn, corn silage, grass hay, concentrated separator byproduct, as well as supplement and included 27.5 mg/kg monensin and 11 mg/kg tylosin. Diets were formulated to contain a minimum of 12.5% CP, 0.7% Ca, and 0.3% P. Steers were implanted on d 0 (36 mg zeranol) and d 60 (80 mg trenbolone acetate and 16 mg estradiol). A 3-d initial weight was collected to establish blocking criteria and another 3-d weight was collected at the end of the growing period. Subsequent weights were collected every 28 d. During the growing period, DMI was not different ( $10.22 \pm 0.23$  kg/d;  $2.42 \pm 0.06\%$  of BW;  $P \geq 0.63$ ). Steer performance, including ADG ( $1.75 \pm 0.05$  kg/d) and G:F ( $174.1 \pm 6.8$  g/kg), was not affected ( $P \geq 0.14$ ) by treatment during the growing period and final BW at the end of the growing period was not different ( $425 \pm 7$  kg;  $P = 0.99$ ). During the finishing period, DMI was not different ( $8.47 \pm 0.66$  kg/d;  $1.57 \pm 0.09\%$  BW;  $P \geq 0.27$ ). No differences ( $P \geq 0.22$ ) during the finishing period were observed for ADG ( $1.54 \pm 0.07$  kg/d) or G:F ( $202.4 \pm 28.3$  g/kg). As a result final BW was not different ( $551 \pm 15$  kg;  $P = 0.28$ ). These data suggest DDGS can be included at 30% dietary DM, partially replacing dry rolled corn, with no detrimental effects on intake, ADG, or G:F in growing and finishing steers.

**Key Words:** beef cattle, distillers dried grains with solubles, growth

**295 The effect of level of wet distillers grains plus solubles and**

**condensed corn distillers solubles ensiled with wheat straw on performance of growing steers.** M. M. Peterson<sup>\*</sup>, M. K. Luebbe, R. J. Rasby, T. J. Klopfenstein, and L. M. Kovarik, *University of Nebraska, Lincoln*.

Crossbred steers ( $n=88$ ) were individually fed using Calan gates for 80 days. Based on body weight, steers were stratified and blocked by light, medium, or heavy weights. Steers were randomly assigned to treatment within each weight block (8 steers per treatment). The objective was to evaluate blends of ensiled condensed corn distillers solubles (DS) and ensiled wet distillers grains plus solubles (WDGS) with wheat straw on performance of growing calves. Treatments included: 25% DS, 35% DS and 45% DS ensiled with wheat straw and 25% WDGS, 35% WDGS, 45% WDGS and 55% WDGS combined with wheat straw. Four combinations included 17.5% DS and 17.5% WDGS, 25% DS and 10% WDGS, 25% DS and 20% WDGS, 26.25% DS and 8.75% WDGS. Sulfur ranged from .25 to .55% and fat varied 3.6 to 7.6% of the diet. A negative quadratic trend ( $P=0.069$ ) for F:G (4.60, 5.21, 3.99) was observed as inclusion of solubles increased. The DMI and ADG increased linearly ( $P < 0.01$ ) as the WDGS inclusion increased from 25 to 55%. F:G of WDGS treatments decreased (4.77, 4.17, 3.11) linearly ( $P < 0.01$ ) as the level of inclusion increased. The DS 17.5% + WDGS 17.5% treatment had a lower ( $P < 0.01$ ) intake (4.33 kg) compared to steers on the DS 25% + WDGS 20% (5.23 kg) treatment. However, F:G was not different ( $P > 0.10$ ) among the four treatment blends. The blends totaling 35% byproduct had gains of 0.45 to .50 kg/d were similar to either of the byproducts fed alone. The 25% DS + WDGS 20% blend showed similar ADG when compared to byproducts fed alone. There appears to be no associative effect of feeding the DS and WDGS combinations. Steers responded positively to increasing levels of either DS or WDGS and the feeding values of solubles were at least equal to WDGS. Blends of DS and WDGS gave similar performance to either DS or WDGS fed alone.

**Key Words:** calves, distillers grains, intake

**297 Distillers' grains—soy hull diets as a corn replacement for feedlot cattle.** C. O. Trejo<sup>\*1</sup>, L. L. Berger<sup>1</sup>, T. G. Nash<sup>1</sup>, and L. Forster<sup>2</sup>, <sup>1</sup>*University of Illinois, Urbana*, <sup>2</sup>*Archer Daniels Midland Company, Decatur, IL*.

The addition of by-products in beef cattle diets is being used to reduce feed cost without affecting cattle performance. The supply of distillers grains and soy hulls has increase rapidly in the past three years. Data was compiled from three experiments during three years in which five hundred and twenty five Angus, Simmental, and Angus-Simmental steers were fed four dietary treatments. Dietary treatments were defined as: (1) 75% dry rolled corn (DRC), 15% corn silage (CS); (2) 50% DRC, 25% dry distiller grains (DDG), 15% CS; (3) 40% DDG, 35% soy hulls (SH), 15% CS; (4) 40% fresh modified wet distiller grains (FWD), 35% SH, 15% CS. The FWD averaged approximately 50% dry matter. Initial weight was similar ( $P=0.98$ ) across dietary treatments. Steers fed diet 3 had the heaviest ( $P < 0.05$ ) adjusted final weight. Adjusted final weight was calculated by dividing the hot carcass weight by the average dressing percent. No significant differences were observed between steers fed diets 4 and 2. However, the lightest cattle were those fed the corn based diet (diet 1). Steers fed dietary treatment 3 had the highest dry matter intake ( $P < 0.001$ ), consuming 12% (1.18 kg) more daily than the other steers. Steers fed diet 1 had the lowest intake. On average, steers had a daily gain of 1.56 kg/d. However, steers fed diet 3 gain 0.25, 0.14, and

0.09 kg more than those fed diets 1, 2, and 4, respectively ( $P < 0.001$ ). Feed efficiency was similar ( $P = 0.40$ ) across dietary treatments. Carcass evaluation showed heavier carcass weight for steers fed diet 3. Furthermore, higher marbling scores ( $P < 0.05$ ) were achieved in steers fed diets 2 and 3. The addition of distillers grains (dry or fresh) and soy hulls in finishing diets enhanced performance when compared to a traditional corn-based finishing diet.

**Key Words:** distillers grains, soy hulls, feedlot cattle

**298 Effects of differing levels of glycerol supplementation on performance and carcass characteristics in feedlot steers.** K. Culp<sup>\*1</sup>, C. Fleenor<sup>1</sup>, M. Claeys<sup>1</sup>, R. Lemenager<sup>1</sup>, and S. Lake<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>University of Wyoming, Laramie.

The objectives of this study were to evaluate the effects of glycerol supplementation as an energy source in the diet on feedlot performance and carcass characteristics in finishing steers. Forty-eight Angus-Simmental cross steers ( $432 \pm 10$  kg initial BW) that were back grounded prior to the finishing period were blocked by BW and randomly assigned to one of four finishing diets (12 steers/treatment) containing differing percentages of glycerol (0, 5, 10, or 15% of DM). The steers were fed ad libitum in individual pens with feed refusals weighed daily to determine amount of feed consumed. All steers were weighed and ultrasound measurements were taken every 28 d to monitor performance and 12th rib fat accretion. Steers were slaughtered once they reached a final fat depth of approximately 1.14 cm. Following harvest, hot carcass weights were taken, and following a 24-h chill, dressing percent, 12th rib fat depth, LM area, KPH %, yield grade, marbling score and quality grade were determined. There were no differences among treatments for initial BW ( $P = 0.99$ ), days on feed ( $P = 0.95$ ), ADG ( $P = 0.28$ ), G:F ( $P = 0.30$ ), DMI ( $P = 0.71$ ), and final BW (0.98). No carcass characteristic differences were detected for HCW ( $P = 0.96$ ), 12th rib fat depth ( $P = 0.21$ ), REA ( $P = 0.95$ ), KPH % ( $P = 0.81$ ), yield grade ( $P = 0.55$ ), marbling score ( $P = 0.85$ ), or percent carcasses grading USDA choice or better ( $P = 0.69$ ). Glycerol supplementation had no effect on performance traits or carcass characteristics of feedlot cattle that had previously been exposed to an extended back grounding period. The present study suggests crude glycerol (90 % glycerol) may be used as a substitute for corn in feedlot

finishing diets at levels up to 15% (DM basis) without causing adverse effects on performance or carcass quality.

**Key Words:** crude glycerin, feedlot, steers

**299 Effect of a lactic acid-lactobacillus preservative and moisture level at baling on in-situ digestibility of crabgrass hay by heifers.** J. D. Caldwell<sup>\*1</sup>, A. E. Killion<sup>1</sup>, L. A. Hardin<sup>1</sup>, K. P. Coffey<sup>1</sup>, A. N. Young<sup>1</sup>, D. Philipp<sup>1</sup>, and W. Coblenz<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>USDA-ARS, Marshfield, WI.

Common crabgrass (*Digitaria ciliaris* [Retz.] Koel.) is a warm-season annual that offers an advantage over many perennial warm-season grasses because of its greater nutritive value and high palatability. However, little is known about how baling crabgrass hay at high moisture affects ruminal forage degradation. Our objective was to determine the effects of treating crabgrass at the time of mowing (T) with 81 mL/tonne DM of a solution containing 11% lactic acid and non-viable lactobacillus acidophilus and baling at 2 different moisture levels on ruminal in situ disappearance kinetics. Twelve field plots of crabgrass were assigned randomly to 1 of 4 treatment combinations in a  $2 \times 2$  factorial arrangement. Half of the plots were sprayed with T and half were not treated (U). Within T and U, half of the plots were baled at 18% (M18) moisture and half at 28% moisture (M28). Six bales per plot were selected randomly and stored in insulated 6-bale stacks. Each bale was chopped through a commercial chipper-shredder, mixed thoroughly, and samples were collected from each bale after 42-d of storage and ground through a 2-mm screen. Dacron bags containing the ground forages were incubated in the rumen of 6 cannulated heifers ( $618 \pm 18$  kg BW; 2/block) for 0, 6, 12, 18, 24, 36, 48, 72, 96, and 120 h and DM degradation kinetics were determined. The water-soluble fraction was higher ( $P < 0.05$ ) from M28-T and M18-U compared with M28-U, and effective degradability was higher ( $P < 0.05$ ) from M28-T than the other treatment combinations. The slowly degraded fraction was greater ( $P < 0.05$ ) for M28 compared with M18. The undegraded fraction was the lowest ( $P < 0.05$ ) from M28-T across all treatments. Therefore, treating crabgrass with a lactic acid-lactobacillus product at time of mowing may increase ruminal DM digestibility and allow producers to bale crabgrass hay at higher moisture concentrations.

**Key Words:** crabgrass, digestibility, heifers

## Teaching

**301 Details of a NSF supported research education for undergraduates (REU) training program for recruiting and training future graduate students.** J. Rice<sup>\*</sup>, K. Saunders, and M. Rothschild, Iowa State University, Ames.

Graduate-level research is a workhorse of the modern academic enterprise. Universities are finding it difficult to draw experienced potential students to their laboratories and facilities. Opportunities for qualified undergraduates to gain the needed research experience are far scarcer than the demand, particularly for those attending smaller traditionally non-research colleges and for minorities. The obvious solution is to provide the opportunity for training and experience in fields that are not typically available. We report here on the preliminary progress of a program funded by the National Science Foundation in Genomics and Biotechnology. The 10 week research education program draws 10-11 undergraduates (50% minority) per summer at Iowa State University. Students are assigned to individual faculty mentors and participate in

weekly group meetings and activities and live on campus. The goals of this program are: 1) to provide qualified undergraduates with research training; 2) To educate undergraduates about the demands and requirements of graduate school and academia; 3) To expose undergraduates to current and leading research in advanced fields of science; 4) To foster a cooperative learning environment and encourage the formation of academic connections and 5) To encourage enrollment in graduate school research programs involving animal & plant genetics, genomics, proteomics, and other related fields. Data are collected anonymously three times during the program from student participants. Results over the past three year demonstrate a significant appreciation for the education gained through the program. Student preferences for learning, understanding of research processes and needs are reviewed. Additionally, a majority of participants have gone on to pursue graduate or professional degrees of various levels. Qualitative data taken from the participants and a detailed program description including a typical summer schedule and required tasks will be presented. Program sup-

ported by the National Science Foundation Research Experience for Undergraduates DBI-0552371

**Key Words:** undergraduate, research, experience

**302 Clicker technology for introductory animal science courses.** G. M. Hill\* and J. E. Link, *Michigan State University, East Lansing.*

Introductory animal science classes are larger in size and are serving a greater number of disciplines than in the past. Having been exposed to electronic technologies throughout their education, students expect to be interactive in the classroom. The clicker is a recent innovation that allows a student to respond to questions via radio frequency with a clicker device which is unique to the student. Via a receiver (20 x 13 mm), the results are recorded to a flash drive that can be used to transfer results to a spreadsheet. Following a question in the classroom, this technique can be used to display the responses to all class members or kept hidden to serve as a means of evaluation. During the 2007 fall semester, 149 students representing 27 majors in an introductory animal agriculture course purchased their personal clicker. Following clicker registration, a student's name became associated with the serial number of their clicker for record keeping. Clickers were used to share baseline student demographics by utilizing questions such as 1. Are you from a: (a) city, (b) small town, (c) small farm, (d) large farm where agriculture is the primary source of income? 2. The animals that are the most important in my life are: (a) horses, (b) dogs or cats, (c) pigs, (d) beef cattle, or (e) dairy cattle? These results allowed us to collect information not readily available from students in complete confidence. Additionally, clickers were used as myth busters with questions such as 1. I am sleepy after Thanksgiving dinner because of the turkey I consumed (true or false). Obviously, a teaching moment relative to tryptophan occurs. To close the semester, clickers were used to evaluate laboratory experiences for the next semester planning. Pitfalls encountered in the use of clickers included: (1) student's failure to bring their clicker to class and (2) bringing a friend's clicker to class along with their own to take a friend's clicker quiz. At the end of the semester, over 85% of the students indicated that they enjoyed the interactive experience provided by clickers.

**Key Words:** clickers, interactive technology, undergraduate education

**303 Integrating a food defense educational program across an animal science curriculum.** C. L. Lorenzen\*, M. K. Hendrickson, A. D. Clarke, M. C. Shannon, R. M. Torres, R. L. Weaver, and K. L. Savage-Clarke, *University of Missouri, Columbia.*

Food defense for animal products is the prevention of intentional contamination at any point during the production/processing chain. In order to increase awareness of food defense government directives and industry initiatives by undergraduate students, lectures and laboratories were incorporated into animal production and food product courses. Students were evaluated through pre- and post-lecture assessments to determine if there was an increase in knowledge. Some undergraduate courses included an assignment involving a complete a food defense

plan that was graded to evaluate the application of knowledge gained. In addition, all students were asked to evaluate the educational experience on a five point scale where 1 = strongly disagree and 5 = strongly agree. Criteria for successfully increasing knowledge was a positive change in assessment score, successfully applying knowledge was defined as 90% of the students received a grade of > 70% on their assignment, and successful quality of the educational experience was defined as 90% of the students rated the material > 4. 92.4% of students increased their post-assessment score compared to their pre-assessment score. Students' confidence level increased related to knowledge based on the evidence that 70.5% of the students had decreased usage of "don't know" response on the post-assessment. 92.9% of students scored 70% or more on the food defense plan assignment. Students (n = 197) agreed that presentations were clear and easy to understand (4.3), presented in a logical sequence (4.2), and at a level appropriate for the course (4.3). Students (n = 98) that completed assignments agreed that they were able to assess risks (4.0), describe basic steps in food defense plan development (4.1), create a plan (3.8), and create a response plan (3.9). After experiencing a food defense curriculum, students increased their knowledge and awareness of food defense and were able to apply that knowledge to developing a food defense plan.

**Key Words:** food defense, education

**304 Assessment of Southern Illinois University Carbondale's animal science students' learning styles.** J. M. Douglas\*, R. L. Atkinson, G. A. Apgar, T. A. Winters, and K. L. Jones, *Southern Illinois University, Carbondale.*

Professors attempt to provide an optimal learning environment that is educational for their students. An obstacle the instructor may face is creating curricula that best suits the abilities of the students that populate his/her class. While the pupils change every semester, it may be of benefit to assess the general learning styles of the students so that curriculum modifications can be made. The objective of this investigation was to describe the learning preferences of university students pursuing a degree in animal science (ANS). Using the web-based Felder-Silverman Index of Learning Styles<sup>®</sup> (ILS; <http://www.engr.ncsu.edu/learningstyles/ilsweb.html>) questionnaire, students (n = 117) were asked to complete the test and indicate which specialization within the ANS major they were enrolled (production, n = 39; equine science, n = 42; or pre-veterinary science, n = 36). The ILS assessed four dimensions of learning defined as: sensing/intuitive, active/reflective, visual/verbal, or sequential/global. Following completion of the test, students' scores on each scale were assessed using One-way ANOVA with LSD post hoc testing (SPSS 11.5, Chicago, IL). Differences (P < 0.05) were detected in the active/reflective and visual/verbal variables. Production majors were more active learners than equine or pre-veterinary/science majors. Production majors also preferred visual learning to verbal learning as compared to pre-vet science students. Modifying ANS teaching curricula in response to the learning preferences of students may provide for a more productive learning experience.

**Key Words:** learning styles, animal science, teaching

## Undergraduate Student Competitive Research Papers, Oral Division

**305 Relationship of growth rate and feed efficiency in Suffolk ram lambs.** J. L. Hayes<sup>\*1</sup>, A. B. Culham<sup>1</sup>, G. M. Hill<sup>1</sup>, E. C. Westover<sup>1</sup>, J. E. Link<sup>1</sup>, and M. E. Benson<sup>2</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>Washington State University, Pullman.

Livestock producers are faced with escalating feed costs and consumer demand for healthy lean products. The sheep industry has lagged behind in selecting fast growing animals that retain high carcass merit. Therefore, the objective of our study was to continue evaluation of our high performing Suffolk flock (Benson et al., 2008). In this 6 wk study, data was collected from 19 Suffolk ram lambs born from February 3 to March 18, 2008, and specifically selected for high growth rate. Our goal was to identify differences in animal performance when fed individually in an Osborne electronic feed monitoring system with feed intake recording equipment (FIRE). Ram lambs were creep fed for 4 wk, weaned at approximately 60 days of age and adjusted to a corn/protein pellet diet for 2 wk. A radio frequency identification tag (RFID) to be read by the equipment was placed in an ear. Based on starting date, rams were assigned to pens (5 to 9 rams each) with 1 electronic feeder per pen. Data was analyzed using Proc Mixed (SAS). The study was divided into 2 periods (0-21 and approximately 22-40 d on test). In the first period, ADG of 0.72 kg (range of 0.5 to 0.96 kg) was correlated to ADFI ( $r^2 = 0.57$ ;  $P = 0.004$ ). While in the second period, the 0.61 kg ADG (range of 0.42 to 0.84 kg) was correlated with G/F ( $r^2 = 0.66$ ;  $P = 0.002$ ). Rams were grouped by their growth potential (GP) based on initial ADG: high GP:  $> 0.73$  kg/d, medium GP: 0.68 to 0.72 kg/d and low GP:  $< 0.67$  kg/d ADG. The difference in ADG of rams in the high and low GP groups was 0.23 kg/d regardless of period ( $P < 0.0001$ ). The ADFI differed in period 1 ( $P < 0.01$ ), but not in period 2 ( $P = 0.87$ ). Hence, the high GP rams were more efficient in feed utilization ( $P = 0.04$ ) resulting in greater gains on less feed during the later stages of their growth curve. Therefore, it is possible for the sheep industry to improve the feed efficiency and growth rate simultaneously.

**Key Words:** lambs, growth, feed efficiency

**306 Fatty acid profiles of and iodine value correlations between four carcass fat depots from pigs fed varied combinations of ractopamine and energy.** H. L. Evans<sup>\*1</sup>, R. B. Hinson<sup>1</sup>, B. R. Wiegand<sup>1</sup>, M. J. Ritter<sup>2</sup>, S. N. Carr<sup>2</sup>, K. S. Roberts<sup>1</sup>, and G. Allee<sup>1</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Elanco Animal Health, Greenfield, IN.

The objective of this study was to determine the fatty acid profile of four carcass fat depots (jowl, belly, subcutaneous loin, and intramuscular) from pigs fed varied combinations of ractopamine (RAC, Paylean<sup>®</sup>) and energy. Correlations of calculated iodine value (IV) between the four fat depots were estimated. Dietary treatments (n=6) included corn/soybean meal diets with 1) 4% added fat + 0 g RAC; 2) 0.5% added fat + 0 g RAC; 3) 0.5% added fat + 15% wheat mids + 0 g RAC; 4) 4% added fat + 7.4 ppm RAC; 5) 0.5% added fat + 7.4 ppm RAC; and 6) 0.5% added fat + 15% wheat mids + 7.4 ppm RAC. Carcasses from PIC TR-4 × C22 finishing barrows (n=55; slaughter WT = 123 kg) were sampled for fat tissues at the anterior tip of the jowl, posterior to the sternum on the belly edge, three-quarters the distance around the loin eye (Sub Q), and within the longissimus (IMF). Feeding RAC reduced ( $P < 0.02$ ) total saturated fatty acids (SFA) in Sub Q and IMF and increased ( $P < 0.04$ ) total monounsaturated fatty acids (MUFA) in Sub Q. Also, RAC increased ( $P < 0.01$ ) the IV of IMF. Total MUFA of belly fat was reduced ( $P < 0.05$ ) when the 1.51 average mc cal/lb of ME diet was compared with the 1.61 average mc cal/lb of ME diet. Jowl fat total MUFA was reduced ( $P < 0.05$ ) and total polyunsaturated fatty acids (PUFA) was increased ( $P <$

0.05) when the 1.53 average mc cal/lb of ME diet was compared with the 1.61 and 1.51 average mc cal/lb of ME diet. Iodine values, independent of treatment, were 60.97, 64.51, 55.59, and 58.26 for belly, jowl, IMF, and Sub Q fat depots, respectively. Correlation estimates indicated that IMF (0.46) and Sub Q fat (0.23) served as stronger predictors of belly fat IV than jowl fat (-0.14). Dietary RAC at 7.4 ppm will shift the fatty acid profile from SFA to MUFA in Sub Q and IMF depots. RAC supplementation did not change belly fat profiles, thus avoiding the potential negative effect of softening belly fat which is detrimental to processing value. Using IV of jowl fat to predict belly firmness may not be appropriate given the weak correlative relationship.

**Key Words:** pork, ractopamine, iodine value

**308 Effects of sire by implant interactions on carcass traits in Hereford cattle.** J. A. Bishop<sup>\*</sup> and D. W. Moser, Kansas State University, Manhattan.

The effects of sire by implant interactions were evaluated in Hereford cattle to determine if sire evaluations would re-rank based on hormone implant status of progeny. Data were collected from the American Hereford Association young sire evaluation program. Fourteen sires were randomly assigned to dams, producing 254 progeny. Calves born from the same ranch were fed together in a commercial feedlot. Each sire's progeny were randomly assigned to two groups: implant and no implant. Traits analyzed were ribeye area, 12th rib fat thickness, calculated USDA yield grade, hot carcass weight, and marbling score. The data were analyzed with a linear model that included random effects of sire and sire by implant interaction, fixed effects of implant status and breed composition of dam, and a covariate for age of dam. Significance of the sire by implant interaction was evaluated using a likelihood ratio test, comparing full and reduced models. The results showed that sire by implant interactions were not significant for any of the evaluated traits. This results in sires ranking similarly whether progeny are implanted or not implanted. Implant status significantly impacted all five carcass traits. These results agree with many past studies, showing that growth hormone implants will improve ribeye area ( $P < .02$ ) and hot carcass weight ( $P < .0001$ ), and that not using implants will increase marbling ( $P < .01$ ). However, our data disagreed with previous studies as to how implants affect fat thickness, finding implanted cattle to have greater fat thickness ( $P < .05$ ). This information could be important for breeders interested in participating in the growing natural food market. Breeders can utilize current genetic evaluation information on carcass traits to help meet the growing demand for natural foods.

**Key Words:** genotype by environment interaction, growth implants, beef cattle

**309 The nutritional efficacy of mare milk in neonatal pigs.** E. L. Wilsplotz<sup>\*</sup>, A. Willyard, A. Buckley, and N. L. Trottier, Michigan State University, East Lansing.

The overall goal of this study was to test the hypothesis that mare milk-based diets fed to neonatal pigs are nutritionally more efficacious than cow milk-based diets. The specific aims were 1) to determine the growth performance of neonatal pigs fed either fresh mare milk or low fat (1% wt/vol) cow milk; and 2) to determine the growth performance of neonatal pigs fed milk replacer based on powdered mare or fat-free cow milk. For each experimental aim, 10 one day-old pigs (mixed sex) were assigned to two experimental diets in a randomized design. Five

pairs of piglet siblings were obtained from five sows, and each piglet within a pair was allocated to either a mare or a cow milk-based diet. The remaining piglet siblings on each of the five sows served as a positive Control group. In experiment (Exp.) 1 and 2, piglets were monitored for a total of 5 and 7 d, respectively. Piglets were individually penned in compartments located above their original farrowing crates and provided with additional heat. Piglets were fed hourly and provided fresh pasteurized mare or cow milk at a rate of 100 mL/h by d 3 in Exp. 1 and 50 mL/h daily in Exp. 2. All piglets (treatments and sow-reared) were weighed daily. In Exp. 1, the mare and cow milk were composed (wt/vol) of 3.2 and 2.1 % protein, 1.2 and 1 % fat, and 6.37 and 4.9 % lactose, respectively. In Exp. 2, both the mare and cow milk-based diets contained (wt/wt) 30 % CP and 20 % fat; the mare and cow milk-based diets contained (wt/wt) 38.15 and 35.75 % lactose, respectively. Diets were reconstituted with distilled water in a ratio of 20:80. In Exp. 1, ADG (g/d) of mare milk compared to cow and sow-reared piglets did not differ ( $P = 0.145$ ) ( $171$  vs.  $255 \pm 29$  and  $171$  vs.  $149 \pm 29$ , respectively); when compared to cow milk-fed piglets only, ADG tended to be lower ( $P = 0.11$ ). In Exp. 2, ADG (g/d) of mare milk-fed compared to cow milk-fed piglets was lower ( $P < 0.01$ ) ( $215$  vs.  $338 \pm 23$ ) and did not differ when compared to sow-reared piglets ( $215$  vs.  $280 \pm 23$ , respectively). In conclusion, mare milk-based diets are inferior to cow milk in supporting neonatal growth.

**Key Words:** piglet, mare, milk

**310 Effect of dietary conjugated linoleic acid and coconut oil on muscle lipid content in mice.** K. M. Kanosky\*, S. Ippagunta, and K. M. Barnes, *West Virginia University, Morgantown.*

Conjugated linoleic acid (CLA) is a group of fatty acids that cause rapid body fat loss in many species. Coconut oil (CO) diets enhance the anti-obesity effect of CLA in mice. CLA feeding in pigs has resulted in decreased backfat and increased marbling. The objectives of this study were to determine if fat accumulates in skeletal muscle of CLA fed mice. Eighty male mice were weaned at 3 weeks of age and randomly allotted to diets: 7% soy oil (SO) or 7% CO and fed for 42 days. For an additional 12 days, half of the mice on each diet were supplemented with 0.5% CLA isomers in place of the basal oil, giving treatments of SO+CLA and CO+CLA, respectively. Feed intake and body weight were measured weekly. At the conclusion of the feeding period mice were killed and retroperitoneal (RP), epididymal (EPI) fat pads, and thigh skeletal muscle were removed and weighed. A body fat index was calculated as  $((RP + EPI) \div \text{body weight}) \times 100$ . Lipid content of skeletal muscle was measured by ether extraction of freeze-dried samples. There were no significant effects of diet on feed intake or body weight. Both CLA ( $P < 0.01$ ) and CO ( $P < 0.01$ ) reduced the body fat index. However, contrary to previous reports, there was no significant interaction of CO with CLA detected. Both CLA ( $P < 0.05$ ) and CO ( $P < 0.001$ ) also reduced the percent lipid of the skeletal muscle. Muscle lipid ranged from 14% (SO) to 7% (CO+CLA), with CO and SO+CLA being similar (11%). This indicates a decreased accumulation of lipid in the skeletal muscle of mice, similar to the reduction in total body fat. Therefore, unlike in pigs, CLA fed mice may not accumulate lipid in their skeletal muscle. There may, however, be a difference in skeletal muscle type, as we measured thigh muscle in this study and in most pig studies the longissimus muscles have been analyzed.

**Key Words:** conjugated linoleic acid, muscle lipid, mice

**311 Effects of nutritional plane and selenium supply during gestation on milk yield and composition in ewes.** L. J. Garbel\*<sup>1</sup>, A. M. Meyer<sup>1</sup>, J. J. Reed<sup>1</sup>, T. L. Neville<sup>1</sup>, J. D. Kirsch<sup>1</sup>, W. L. Keller<sup>1</sup>, R. M. Weigl<sup>1</sup>, J. B. Taylor<sup>2</sup>, L. P. Reynolds<sup>1</sup>, J. S. Luther<sup>1</sup>, D. A. Redmer<sup>1</sup>, J. S. Caton<sup>1</sup>, and K. A. Vonnahme<sup>1</sup>, <sup>1</sup>*North Dakota State University, Fargo,* <sup>2</sup>*USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.*

Forty-two Rambouillet ewe lambs were allocated to dietary treatments in a  $2 \times 3$  factorial design to determine the effects of nutritional plane and Se supply during gestation on lactation. Treatments included adequate Se (ASe, 8.5  $\mu\text{g/kg}$  BW) or high Se (HSe, 80  $\mu\text{g/kg}$  BW) and nutritional plane supplying 60% (RES), 100% (CON), or 140% (HIGH) of NRC requirements fed individually to ewes. At parturition lambs were removed, and ewes were transitioned to a lactation diet supplying 100% requirements and adequate Se. At 3 h post-lambing, colostrum was hand-milked, and ewes were put into the milking rotation. Ewes were injected with 1 mL of oxytocin and milked mechanically at 0500 and 1700 h daily through the morning of d 20 of lactation. At each milking, yield was recorded; milk was sampled for nutrient analysis on d 3, 7, 14, and 20. Ewes on HSe during gestation had greater ( $P < 0.001$ ) daily milk weight (936 vs. 848 g/d) than ASe ewes, whereas RES had lower ( $P < 0.001$ ) daily milk weight (749 vs. 961 and 966 g/d) than CON and HIGH. Total daily milk protein, total lactose, and total solids-not-fat (SNF) were decreased ( $P \leq 0.003$ ) in RES ewes compared to CON and HIGH. Milk from RES had the greatest ( $P < 0.001$ ) % butterfat (BF), CON was intermediate, and HIGH was least. Milk from ewes on RES had greater ( $P < 0.001$ ) % protein than CON and HIGH. Total milk somatic cell count was greater ( $P = 0.04$ ) in CON than RES ewes. There was an effect of day ( $P \leq 0.05$ ) on milk weight, % BF, total BF, % protein, % lactose, and % SNF. Milk weight had a cubic ( $P \leq 0.004$ ) response across day, where yield increased from d 1 to 3 and was similar from d 3 to 19. A linear decrease ( $P < 0.001$ ) was observed for total BF and % protein across day. There was a quadratic effect ( $P \leq 0.003$ ) of day on % BF and % lactose, with the greatest concentrations on d 3. A quadratic effect ( $P = 0.003$ ) was also observed for % SNF, where d 7 was the greatest. Results suggest that nutritional plane and Se supply during gestation affect subsequent ewe milk production and composition, even when ewes are fed to nutritional requirements during early lactation.

**Key Words:** gestational nutrition, lactation, selenium

**312 Impact of time and temperature on tissue quality and diagnostic outcome in swine.** W. Holt\*<sup>1</sup>, J. Reiman<sup>1</sup>, L. Karriker<sup>1</sup>, J. Hanson<sup>2</sup>, L. Layman<sup>1</sup>, and A. Johnson<sup>1</sup>, <sup>1</sup>*Iowa State University, Ames, Iowa,* <sup>2</sup>*Murphy Brown Inc., Rose Hill, NC.*

The temperature of tissues and duration of transportation are components that are recognized to impact tissue autolysis. Tissue autolysis can compromise the accuracy of case conclusions. Therefore, type of diagnostic specimen and transportation environments should be compared to evaluate their impact on diagnostic results. The objective was to compare typical combinations of time and temperature for impact on diagnostic accuracy. A total of 64 samples per treatment were collected. Four treatments were compared on replicate samples from thoracic and enteric field cases. **Treatment A:** samples were harvested and stored at 32°C for 4-h and then shipped on ice 18-h. **Treatment B:** samples were harvested, stored for 4-h and shipped 18-h at 32°C. **Treatment C:** samples were harvested, placed directly on ice and shipped for 18-h. **Treatment D:** samples were harvested, placed directly on ice, frozen at -20°C for 48-h, and then shipped for 18-h on ice. These treatments were chosen to mimic observations of tissue handling in the field.

Samples collected included fresh and fixed tissue, swabs of tissue, and lung lavage (BAL). Diagnostic tests conducted were standard bacterial culture and IHC ELISA, and PCR exclusively for rotavirus, PRRS, and SIV. Results were interpreted descriptively based on case interpretation. In IHC tests for rotavirus, all treatments presented fewer positives in the tissue samples shipped fresh versus tissue samples that were fixed at the collection site prior to shipment. Treatment A had the highest percentage of positive enteric tissue results in IHC tests for rotavirus shipped fresh. Treatment B had reduced levels of non-contaminants in both enteric and respiratory bacteriology cultures. In treatment C the highest numbers of non-contaminants were observed. Treatment D cultured no respiratory bacterial contamination and presented fewer test positives using BAL and swabs in PCR testing for PRRS. These results suggest that shipping environment impacts the accuracy of diagnostic conclusions, and the impact may be test and sample type specific.

**Key Words:** diagnostics, PRRS, swine

**313 Lean gain in Suffolk ram lambs relative feed efficiency and cost.** E. C. Westover<sup>\*1</sup>, A. B. Culham<sup>1</sup>, G. M. Hill<sup>1</sup>, A. L. Bushman<sup>1</sup>, J. E. Link<sup>1</sup>, J. L. Hayes<sup>1</sup>, and M. E. Benson<sup>2</sup>, <sup>1</sup>Michigan State University, E. Lansing, <sup>2</sup>Washington State University, Pullman.

With rising feed costs, it is critical to understand composition of growth and feed efficiency in lambs. Therefore, our objective was to evaluate lean growth, efficiency of gain and cost in Suffolk ram lambs. February born lambs were creep fed a 21% protein diet until weaned at about 70 d of age (DOA). Rams were acclimated (25 d) and then fed a 15% protein diet that met or exceeded the NRC requirements (1985) for rapid growth potential. At approximately 95 DOA, rams were shorn, fitted with an electronic ear tag, sorted into 2 pens. Each pen contained 1 Osborne electronic feed intake monitoring system. Weight and feed intake were recorded each time a ram entered and exited the feeder. The ADG, G/F, and composition of gain data were collected for 11 rams. Rams' average initial weight was 57.37 kg and end weight (21 d) was 73.8 kg with an ADG of 0.78 and a cost of \$0.08/kg of gain. The G/F was  $3.63 \pm 1.46$ . Rams were ultrasounded (Pie Medical Machine, Model: 41263) at 0 and 21 d to estimate BF and LEA at the 12th rib. Body wall thickness was determined from the animal's BF (Boggs and Merkel, 1993). Percent boneless, closely trimmed retail cuts (% BCTRC) was calculated (S. P. Griener, personal communication):  $49.936 - (0.0848 * \text{carcass wt}) - (4.376 * \text{BF}) - (3.53 * \text{body wall}) + (2.4756 * \text{LEA})$ . Lean gain per day was calculated utilizing 50% dressing percent, the animal's initial weight, BCTRC, and days on trial. Rams averaged  $0.28 \pm 0.09$  kg lean gain/d after 21 d. The rams in the higher lean gain/d group ( $> 0.27$  kg) averaged 8.60 cm<sup>2</sup> LEA with 0.43 cm of BF, while the lower lean gain/d rams ( $< 0.27$  kg) had 8.30 cm<sup>2</sup> LEA with 0.30 cm of BF. Higher lean gain rams had a higher ADG than lower lean gaining rams (0.86 vs. 0.67,  $P = 0.05$ ). The  $r^2$  between lean gain and G/F was 0.92 ( $P = 0.01$ ) for higher lean gain rams, but was not significant for lower lean gain rams. Therefore, total cost of producing lean gain can be reduced by selecting rams with a greater lean gain growth potential.

**Key Words:** sheep, growth, lean gain

**314 Measuring the compositional and instrumental firmness variations in fresh pork bellies.** K. A. Trusell<sup>\*</sup>, J. K. Apple, J. W. S. Yancey, T. M. Johnson, and R. J. Stackhouse, University of Arkansas Division of Agriculture, Fayetteville.

Fresh pork bellies ( $n = 24$ ) from pork carcasses with an average weight and fat-free lean yield of  $93.6 \pm 5.2$  kg and  $51.8 \pm 2.0\%$ , respectively,

were cut into 15 sections to measure the intra-belly variation in compositional and mechanical firmness characteristics. Range in belly-plot measurements was 8.9 to 24.8 cm when measured skin-side down and 10.0 to 30.0 cm when measured skin-side up. Length and width of each belly was measured before it was divided into 3 rows (D = dorsal; C = central; and V = ventral) and 5 columns (labeled 1, 2, 3, 4, and 5 from anterior to posterior), resulting in 15 belly sections of equal dimensions. Thickness of all 4 sides of each section was averaged before two 2.5-cm-diameter cores were removed and compressed to 50% their average thickness between compression plates, whereas each section was also punctured twice with a 1.3-cm-diameter, rounded-tip bar. Then, each section, including the compressed cores, was knife-dissected into lean, fat and skin components and component weights were recorded to calculate composition of each belly section. The lean and fat portions from each belly section were then ground twice, and composite section samples were used to measure moisture content. The belly section with the greatest ( $P < 0.05$ ) compression value was D-1 (88.86 kg), whereas the lowest ( $P < 0.05$ ) compression value was found in the V-4 (36.97 kg) section (column  $\times$  row,  $P < 0.001$ ). Conversely, the greatest ( $P < 0.05$ ) and least ( $P < 0.05$ ) puncture values were observed in the C-2 and V-5 locations, respectively (column  $\times$  row,  $P = 0.016$ ). The greatest ( $P < 0.05$ ) and lowest ( $P < 0.05$ ) fat percentages were found in the D-3 (75.2%) and C-4 (29.5%) sections, respectively, and the greatest ( $P < 0.05$ ) and lowest ( $P < 0.05$ ) lean percentages were observed in the V-1 (57.7%) and D-3 (11.3%) sections. Lastly, the D-3 section had the greatest ( $P < 0.05$ ), whereas the C-4 section had the lowest ( $P < 0.05$ ), moisture content (column  $\times$  row,  $P < 0.001$ ). It is apparent from these results that there is considerable intra-belly variation in the composition and firmness of fresh pork bellies.

**Key Words:** pork belly, firmness, composition

**315 Determination of amino acids digestibility and calculated energy values for a high-protein sorghum DDGS in growing pigs.** H. L. Frobose<sup>\*</sup>, J. Y. Jacela, J. M. DeRouchey, S. S. Dritz, M. D. Tokach, J. L. Nelssen, and R. D. Goodband, Kansas State University, Manhattan.

Fractionation of traditional DDGS to separate the majority of fat and fiber resulting in a higher protein product has become more common; however, nutrient values for these new products must be established for accurate diet formulation. Therefore, an experiment was conducted to determine the amino acid (AA) digestibility and calculated energy value in a high-CP sorghum DDGS. Six growing barrows (BW = 22.7 kg) were surgically fitted with T-cannulas at the terminal ileum. Each was randomly allotted to 2 dietary treatments in a crossover design with 2 periods. The treatments diets were: 1) high-CP sorghum DDGS as the only protein source; and 2) N-free diet for determining basal endogenous AA loss. Both diets contained 0.25% chromic oxide. Ileal digesta samples were collected for amino acid analysis to calculate apparent (AID) and standardized (SID) ileal digestibility. Energy values were calculated based on chemical nutrient analysis. The analyzed nutrient composition on a DM basis was 48.5% CP, 3.2% crude fat, 17.5% ADF, 20.5% NDF, 0.13% Ca, and 0.82% P. The DM was 91.88%. Also, it contained 1.73% Lys on a DM basis, with other AA and their AID and SID values reported in Table 1. For energy, the analyzed GE was 5,108 kcal/kg of DM. The calculated DE, ME, and NE energy values were 3,878, 3,549 and 2,256 kcal/kg of DM, respectively. High-CP sorghum DDGS is higher in CP, AA, Ca, and P but lower in AA digestibility and energy than reported research evaluating traditional DDGS.

**Table 1. Amino acid composition and digestibility coefficients**

Amino Acid	%1	SID, %	AID, %
Arginine	1.85	79.5	77.7
Cysteine	0.80	67.9	66.2
Histidine	1.11	65.2	64.0
Isoleucine	2.18	71.8	70.8
Leucine	5.89	75.5	74.9
Lysine	1.73	56.9	55.1
Methionine	0.85	75.6	74.9
Threonine	1.79	65.6	63.2
Tryptophan	0.39	75.7	73.6
Valine	2.63	70.3	68.8

<sup>1</sup>Dry matter basis

**Key Words:** digestibility, pig, sorghum DDGS

**316 Effects of nutritional plane and selenium supply during gestation on ewe colostrum quality, mammary gland growth, and lamb serum IgG.** S. I. Fry\*<sup>1</sup>, J. F. Thorson<sup>1</sup>, A. M. Meyer<sup>1</sup>, J. J. Reed<sup>1</sup>, T. L. Neville<sup>1</sup>, J. B. Taylor<sup>2</sup>, L. P. Reynolds<sup>1</sup>, J. S. Luther<sup>1</sup>, D. A. Redmer<sup>1</sup>, K. A. Vonnahme<sup>1</sup>, C. J. Hammer<sup>1</sup>, and J. S. Caton<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

To examine effects of nutritional plane and Se supply during gestation on mammary development, colostrum quality, and lamb passive immunity, 84 Rambouillet ewe lambs were randomly assigned to a 2 × 3 factorial design. Treatments included adequate Se (ASe, 8.5 µg/kg BW) or high Se (HSe, 80 µg/kg BW) initiated at breeding and 60% (RES), 100% (CON), or 140% (HIGH) of NRC requirements initiated at d 40 of gestation. Diets were fed to individually housed ewes once daily. At parturition lambs were removed from their dams and placed on a bovine IgG source colostrum replacer. Lamb blood samples were collected at 24 h for serum IgG analysis. Colostrum was collected from ewes 3 h post-partum, yield was measured, and samples were taken for DHIA analysis. Within 24 h of parturition, 42 ewes (7/treatment) were slaughtered and mammary tissues were collected. Data were analyzed using PROC GLM of SAS with effects of Se supply, nutritional plane, and their interaction used in the model. Lambs born to RES ewes had increased ( $P = 0.01$ ) serum IgG compared to lambs born to CON and HIGH ewes (1,754 vs. 1,366 and 1,191 mg/dL). Ewes on the CON diet had greater ( $P = 0.01$ ) colostrum weight (579 vs. 381 and 388 g) than RES and HIGH, whereas HSe ewes had increased ( $P = 0.01$ ) colostrum weight (532 vs. 367 g) compared to ASe. Colostrum total butterfat was greater ( $P = 0.03$ ) in CON than in HIGH ewes. Ewes fed the CON diet had increased ( $P = 0.01$ ) total colostrum protein and solids-not-fat compared to RES and HIGH. Colostrum total lactose was greater ( $P = 0.02$ ) in CON ewes than RES. Ewes fed ASe had increased ( $P \leq 0.04$ ) percent butterfat and somatic cell count compared to HSe, although HSe had greater ( $P \leq 0.04$ ) total butterfat, total protein, total lactose, total solids-not-fat, and total milk urea nitrogen than ASe. Mammary weight was greater ( $P = 0.02$ ) in HIGH ewes compared to RES, and tended ( $P = 0.08$ ) to be greater in HSe than ASe. These data indicate that nutritional plane and Se supply play a significant role in mammary and colostrum composition in pregnant ewe lambs as well as passive immunity of their offspring.

**Key Words:** colostrum, gestational nutrition, selenium

**317 Evaluation of lean growth and daily gain in two maternal lines of pigs.** E. C. Mahan\*<sup>1</sup> and T. A. Rathje<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Danbred North America, Columbus, NE.

Maternal nucleus lines of pigs are selected primarily on reproduction traits. Most breeding objectives for maternal lines include a weighting on terminal performance. Selection on terminal traits will result in changes to patterns of lean tissue accretion, requiring regular updates of adjustment factors for these traits. Two maternal lines were evaluated for backfat (BF), loin eye depth (LED) and average daily gain (ADG) to study differences in lean growth patterns. A total of 149 Yorkshire (YY) and 434 Landrace (LL) gilts were weighed at an average age of 87 d over a 5 week period beginning in May of 2008. Pigs were re-weighed and BF and LED measurements were taken using an Aloka 500 ultrasound machine, every 21 d during the trial (total of five weigh points). Statistical models were fitted to the data using the PROC MIXED procedure of SAS<sup>®</sup>. The random effects of barn, pen within barn and litter were included in all models. The model for BF and LED included the fixed effect of line, the linear and quadratic covariate of weight, and all interaction terms. Weight-adjusted BF and LED were compared between lines within period. Average daily gain was compared both within weigh period and cumulatively for the entire trial. The pattern of BF and LED accretion per kg of body weight gain for YY and LL gilts was not different and was explained by a second order polynomial ( $P < .0001$ ). YY gilts had greater backfat and loin depth at all weigh periods ( $P < .0002$  to  $P < .07$ ). LL and YY gilts grew at the same rate during the first 3 weeks of the trial ( $P = .95$ ) and between weigh period 3 and 4 ( $P = .3553$ ). Between periods 2 and 3, 4 and 5 and overall, LL gilts had a higher ADG ( $P < .03$ ). LL gilts had a higher rate of growth from birth to the first weigh period ( $P < .0001$ ). Further analysis will be done to develop improved adjustment factors for ADG for these lines and to better understand the underlying causes for the inconsistent patterns of growth.

**Key Words:** lean growth, pigs, selection

**318 Effects of round bale feeding method on hay dry matter intake and eating behavior by beef cows.** B. Wilson\*, L. A. Pacheco, N. A. Sproul, J. R. Jaeger, T. T. Marston, and K. C. Olson, Kansas State University, Manhattan.

Effects of round bale feeding method on DMI of brome hay (7.9% CP; 40.4% ADF) and eating behavior of beef cows were evaluated in a 3-treatment, 6-period Latin square experiment. Angus × cows ( $n = 165$ ; average initial BW = 530 ± 54 kg) with calves were assigned randomly to 1 of 3 native tallgrass pastures (122 ha) for the winter feeding season. Three bale-feeding systems were evaluated: bales fed in a ring feeder (FEEDER), bales unrolled on the ground (UNROLL), and bales chopped with a flail-type processor and discharged onto the ground in a windrow (15-cm particle length; WINDROW). Treatment sequence was assigned randomly to each pasture. Centrally-located feeding areas (30.5 × 15.3 m) in each pasture were covered with polyethylene tarps and were continuously monitored with motion-sensitive cameras. One round bale (526 ± 31 kg) was fed per pasture per 24-h feeding period. The string used to bind bales in FEEDER and UNROLL treatments was removed from bales prior to feeding; string was not removed from WINDROW bales prior to processing and feeding. The amount of uneaten hay at the end of each 24-h feeding period was not different ( $P = 0.32$ ) between treatments (63.5, 131, 111.6 kg for FEEDER, UNROLL, and WINDROW, respectively). Total DMI per cow and DMI per cow per h were

similar ( $P > 0.22$ ) between treatments. The weight of string used to bind each FEEDER and UNROLL bale was not different ( $P = 0.31$ ) from the amount of string recovered on the flail tube of the hay processor after each WINDROW bale was processed. The frequency and duration of herd visits to each bale-feeding site were similar ( $P > 0.24$ ) between treatments; moreover, the frequency and duration of herd visits to feeding

sites during nighttime hours were similar ( $P > 0.55$ ) between treatments. In summary, hay DMI, hay refusal, and eating behavior by cows were not affected by round bale feeding method under the conditions of our study. The string used to bind large, round hay bales may be largely recovered on the flail tube of flail-type hay processors.

**Key Words:** beef cows, forage processing, hay feeding

## Undergraduate Student Competitive Research Papers, Poster Division

**319 Feed efficiency, temperament, ultrasound measurements, and growth in developing Angus heifers.** B. L. Winslow\*, K. A. Gray, M. H. Poore, C. S. Whisnant, and J. P. Cassady, *North Carolina State University, Raleigh*.

The objective of this study was to evaluate phenotypic relationships among feed utilization, backfat, ribeye area, temperament, and frame size in Angus heifers. Data were collected over 2 yrs (2006-2007) from females raised at the Upper Piedmont Research Station in Reidsville, NC. In year 1 heifers ( $n = 49$ ) began the feeding trial at age  $299 \pm 3.2$  d, weighing  $270 \pm 4.9$  kg and in year 2 ( $n = 54$ ) began at age  $286 \pm 2.8$  d, weighing  $290 \pm 4.8$  kg. Heifers were allowed a 2-wk period of adaptation to Calan® gates and the roughage-based ration (target gain rate of 0.91 kg/d). Following adaptation, heifers began an 84 d test. Feed offered was recorded daily and body weights were taken every 14 d. Linear regression of weight on time was used to estimate ADG. Residual feed intake (RFI) was calculated with a model including the dependent variable DMI/d, year as a fixed effect, and regression covariates 42-d mid-weight and ADG. Means and SE for ADG and DMI were  $0.96 \pm 0.018$  kg and  $6.83 \pm 0.152$  kg/d, respectively. Average feed conversion ratio (FCR; DMI/d /ADG) was  $7.44 \pm 0.226$ . At the beginning, middle, and end of the test chute exit velocity (EV), chute temperament scores (TS; TS = 1 = most docile to TS = 5 = highly agitated), ultrasound scans, and hip heights were recorded. Partial correlation coefficients adjusted for year were found to be 0.44 ( $P < 0.01$ ) between RFI and FCR and 0.67 ( $P < 0.01$ ) between RFI and DMI/d. The phenotypic correlation between RFI and final hip height was  $-0.27$  ( $P < 0.01$ ), and was 0.23 ( $P < 0.03$ ) between RFI and TS. Phenotypic correlations for RFI with adjusted LM area (0.18;  $P < 0.08$ ) and with adjusted rump fat (0.18;  $P = 0.08$ ) approached significance. Correlations between RFI and ultrasonic measurements of IM-fat and rib-fat and between RFI and exit velocity were not statistically different from zero. It was concluded that RFI is not independent of TS and hip height in developing heifers. It will be important to estimate the genetic correlations among these traits to determine if selection for reduced RFI could result in correlated changes in the traits measured herein.

**Key Words:** feed efficiency, growth, beef cattle

**320 Postmortem degradation of desmin in specific muscles from the beef round.** J. M. Binning\*<sup>2</sup>, M. J. Anderson<sup>1</sup>, S. M. Lonergan<sup>1</sup>, and E. Huff-Lonergan<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, <sup>2</sup>Simpson College, Indianola, IA.

The muscles of the round are typically regarded as being less tender than some of the higher quality cuts in the beef carcass. Recent muscle profiling data supported by NCBA has documented the characteristics of many of these muscles, and the data indicate that several muscles have the potential to be marketed as individual value cuts. The objective of this study was to determine the differences in amount and rate of desmin

degradation in specific muscles of the beef round. Ten market weight beef cattle were slaughtered, and muscles were removed from both sides of the carcasses at 24 hours postmortem. Muscles removed included the longissimus dorsi (LD; reference) and the following muscles from the round: gracillus (GR), adductor (AD), semimembranosus (SM), sartorius (SAR), vastus lateralis (VL), and vastus intermedius (VI). Steaks were aged at 4°C to 24 hours, 7 days or 14 days postmortem in vacuum packages. Degradation of the protein desmin was determined using western blot analysis. At 24 hours postmortem, the VL had a higher amount of desmin degradation ( $P = 0.03$ ) than all muscles except the SM. The SM tended to have ( $P = 0.07$ ) more degradation than all other muscles at 7 days. At 14 days no differences ( $P > 0.05$ ) were detected between any of the muscles in amount of desmin degradation. Further analysis of desmin degradation was done by analyzing changes in the amount of degradation over time within each muscle. At 24 hours the AD tended to have less desmin degradation ( $P = 0.10$ ) than at 14 days. At 24 hours in the SM, GR, VI, and LD there was less desmin degradation ( $P < 0.05$ ) than at 7 and 14 days. While in the VL and SAR no difference in ( $P > 0.05$ ) desmin degradation occurred over time. Desmin degradation differences seen over time in the AD, GR, VI, LD, and SAR are reasonably consistent with the previously seen sensory tenderness data in these muscles. The muscles from the round exhibit significantly different biochemical characteristics which in turn relate to and may reveal possible indicators for the tenderness, water holding capacity, and the overall protein degradation of these muscles.

**Key Words:** aging, beef round, desmin

**321 Influence of pre-cyropreservation pH and temperature on boar semen quality.** N. E. Tharp\*<sup>1</sup>, P. Purdy<sup>2</sup>, H. Blackburn<sup>2</sup>, S. Spiller<sup>2</sup>, and T. S. Stewart<sup>1</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>USDA-ARS-NCGRP, National Animal Germplasm Program, Fort Collins, CO.

The influence of shipping temperature and pH on semen quality parameters could determine the effectiveness of current National Animal Germplasm Program protocols. The purpose of this project is to determine associations between pH, shipping temperature, and boar semen quality: cell size, cell intensity, motility, progressive motility, elongation, head size, and beat cross frequency. Semen samples ( $n=199$ ) were shipped to the Fort Collins lab for freezing and analysis from four different boar stud facilities. The mean temperature of all incoming samples was 17.2 degrees Celsius with a range of 12.8 degrees Celsius to 21.7 degrees Celsius. The pH ranged from 5.91 to 7.14 with a mean of 6.74. The temperature from Stud 3 was significantly ( $P < 0.0001$ ) the highest, followed by Stud 2, Stud 1, and Stud 4 was the lowest. The pH was significantly ( $P < 0.0001$ ) highest in value from Stud 1, with Stud 4 being different but lower, and Stud 2 and Stud 3 being lowest and similar to each other. Motility percentage was significantly ( $P < 0.0001$ ) highest from Stud 2 and Stud 4, lowest from Stud 3, with Stud 1 being similar to

all other studs. The progressive motility percentage was significantly ( $P < 0.0001$ ) highest from Stud 2, followed by Stud 4, lowest from Stud 3, with Stud 1 being similar to both Stud 4 and Stud 3. The pH/temperature interaction had an effect on membrane quality and viability. Shipping temperature had a significant quadratic effect on semen quality with the optimal temperature for maximum quality near 17 degrees Celsius. The identification of an optimal shipping temperature for boar semen has important ramifications for boar stud management. Our results would suggest that by maintaining a constant shipping temperature of 17°C will increase the quality and functionality of shipped semen.

**Key Words:** cryo-preservation, semen, transportation temperature

**322 Dietary additions of flaxseed compromised skeletal growth in young pigs.** E. J. Ince\*, B. T. Kook, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin, Madison*.

In earlier studies, skeletal integrity was compromised in neonatal pigs fed diets enriched with n-3 fatty acids (FA), but instability of unsaturated FA may have reduced feed consumption and confounded results. Flaxseeds (FX), a source of n-3 FA, offer potential solutions for stability and consumption problems. The current objective was to determine growth, feed intake, and skeletal responses in pigs (8.4±0.03 kg) fed diets with FX. Crossbred pigs (n=6/diet, 1/pen) were randomly allotted to diets with FX at either 7.5% (7.5FX) or 15% (15FX) or a control (Ctl) diet with corn oil added to equal fat as 15FX. All diets provided 80% of Ca requirements. Pigs were scanned by dual energy X-ray absorptiometry (DXA) at 0, 3, and 6 wk to assess bone mineral content (BMC). BMC gain between wk 0 and 6 was used to calculate Ca and P retention by assuming constant Ca (38%) and P (18%) content in bone ash and Ca (96.4%) and P (80%) in skeletal tissue. Pigs fed Ctl diets gained more and had higher BMC gain ( $P < 0.05$ ) than pigs fed 7.5FX or 15FX, but differences in feed intake were not detected. Differences in skeletal growth could not be explained solely by differences in pig growth. No differences were detected in Ca and P intake, but pigs fed 7.5FX and 15FX retained less Ca and P than pigs fed Ctl. Femur ash reflected similar responses as BMC gain across diet groups. However, modulus of elasticity (ME) and bending moment (BM) of femurs from pigs fed 7.5FX were equal to properties of pigs fed Ctl diets. Femurs from pigs fed 15FX appeared to have lower ( $P > 0.10$ ) ME and BM properties than pigs fed Ctl or 7.5FX diets. In summary, feeding flaxseed to young pigs compromised skeletal growth. Whether n-3 fat or an unidentified inhibitor in FX compromised skeletal growth cannot be determined with the current experimental design.

**Table 1. Dietary Treatments**

Traits	Ctl	7.5	15	SEM
ADG, kg/d <sup>a</sup>	0.58	0.41	0.48	0.04
ADFI, kg/d	0.85	0.76	0.81	0.06
BMC, g/d <sup>a</sup>	6.38	3.11	4.00	0.70
Ca Retention, g/d <sup>a</sup>	2.52	1.22	1.56	0.28
P Retention, g/d <sup>a</sup>	1.44	0.70	0.89	0.16
Femur ash, g <sup>a</sup>	17.08	12.82	14.27	1.00
Femur ME, kg/cm <sup>2</sup>	67.64	63.94	50.15	6.5
Femur BM, kg	1150	1107	1049	214

<sup>a</sup>difference between Ctl vs FX diets,  $P < 0.05$

**Key Words:** swine, n-3 fatty acids, skeletal growth

**323 Evaluation of fermented soybean meal in diets fed to weanling pigs.** O. J. Rojas\*, B. G. Kim<sup>1</sup>, and H. H. Stein<sup>1</sup>, <sup>1</sup>*National University of Colombia, Bogota, Colombia*, <sup>2</sup>*University of Illinois, Urbana*.

PepSoyGen® (Nutraferma, Sioux City, IA) is a novel feed ingredient that is produced from fermentation of high protein soybean meal in the presence of *Aspergillus oryzae* and *Bacillus subtilis*. This product contains on an as-fed basis 91.3% DM, 53.7% CP, 3.11% Lys, 0.76% Met, 0.8% ether extract, 3.3% crude fiber, 0.29% Ca, and 0.82% P. The objective of the experiment was to compare performance of pigs fed diets containing PepSoyGen with performance of pigs fed diets containing fish meal or whey powder. A total of 300 pigs with an initial BW of 7.67 ± 0.84 kg were allotted to 5 treatments in a randomized complete block design based on initial BW. There were 10 replicate pens per treatment and 6 pigs per pen. Pigs were weaned 7 d before the start of the experiment and had been fed a common phase 1 diet from weaning and until the start of the experiment. The diets fed during the initial 2 weeks of the experiment were 1) the positive control diet containing 8% fish meal and 15% whey powder, 2) the negative control diet in which all fish meal and whey powder were replaced by corn and soybean meal, 3) a diet where PepSoyGen (9.0%) replaced fish meal, 4) a diet where PepSoyGen (2.5%) replaced whey powder, and 5) a diet where PepSoyGen (11.5%) replaced both fish meal and whey powder. Soybean oil and crystalline AA were included as needed to balance the concentration of ME, Lys, Met + Cys, Thr, and Trp among diets. From d 14 to 35 of the experiment, pigs were fed a common diet based on corn and soybean meal. Results of the experiment showed that from d 0 to 14, there were no differences among treatments in ADG (306, 303, 302, 280, and 316 g/d) and ADFI (452, 428, 438, 428, and 438 g/d), but G:F (0.677, 0.708, 0.693, 0.654, and 0.722) was greater ( $P = 0.023$ ) for pigs fed the diet containing PepSoyGen and no fish meal or whey powder compared with pigs fed the positive control diet or the diet in which PepSoyGen replaced only whey powder. During the following 3 wk, growth performance was not different among treatment groups. The present results indicate that PepSoyGen can effectively replace protein sources of animal origin in diets fed to weanling pigs.

**Key Words:** fermented soybean meal, PepSoyGen, pigs

**324 Effect of feeding yeast culture in the diets of late gestation and lactating sows and gilts on sow and litter performance.** C. Stangohr\*, T. Kellner<sup>2</sup>, G. Fitzner<sup>3</sup>, J. Sonderman<sup>4</sup>, and C. Hostetler<sup>1</sup>, <sup>1</sup>*South Dakota State University, Brookings*, <sup>2</sup>*University of Nebraska, Lincoln*, <sup>3</sup>*Diamond V, Cedar Rapids, IA*, <sup>4</sup>*Danbred North America, Columbus, NE*.

The purpose of this study was to determine the effect of including yeast culture (YC) product (XPC; Diamond V, Cedar Rapids, IA) in sow gestation and lactation diets on sow and litter performance. A total of 1,012 sows, from a 5,000 sow unit, which were between 14 and 10 weeks of gestation was used in this study. Sows were randomly allotted to receive YC during gestation and lactation (YC:YC; n=253), YC during gestation only (YC:NO; n=224), YC during lactation only (NO:YC; n=285) or standard gestation and lactation diet without YC (CONT; n= 250). During gestation, YC was top dressed at a rate of one teaspoon (approximately 5g) daily. During lactation, YC was included at a rate of 2g/kg of diet. Production data including conception rate, total number born, number born alive, number born dead and number of pigs weaned, was maintained using a commercial software package (AgroSoft North America Inc., Toronto, ON). The sixty crate farrow-

ing rooms (4 rows of 15 crates each) were divided in half with sows to receive the same treatment during lactation placed on the same side of the room. The farm practiced intense cross fostering in order to attain their production goals. Pigs were fostered within treatment during the lactation period. A subsample of litters (n=60/treatment) was randomly selected for measurement of total litter weight at weaning. No significant difference ( $P > 0.1$ ) was observed in the conception rate, total number born, number born alive, number born dead and number of pigs weaned. A significant difference ( $P < 0.06$ ) was observed in the litter weaning weight with YC:YC>CONT=NO:YC>YC:NO (57.1, 55.0, 53.7 and 51.8 kg respectively). These results indicate that addition of YC to sow diets during both gestation and lactation increases litter weaning weight compared to control-fed sows or to those sows fed YC in diets during gestation or lactation only.

**325 Dietary inclusion of crude glycerol in a growing-finishing meat goat system.** K. S. Roberts\*<sup>1</sup>, B. R. Wiegand<sup>1</sup>, C. Clifford-Rathert<sup>2</sup>, M. S. Kerley<sup>1</sup>, C. K. Cave<sup>2</sup>, and A. N. Stewart<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Lincoln University, Jefferson City, MO.

The objective of this study was to evaluate 10% crude glycerol from soydiesel production as an alternative energy source for growing-finishing meat goats. Boer goats (n = 24) were assigned to one of six pens with four goats each. Pens were assigned to either a control diet (CON) consisting of 60% high quality alfalfa and 40% concentrate (corn, soybean meal, DDGS) or a diet where corn was replaced at 10% with crude glycerol (GLY). Pen was the experimental unit. Goats (23.4 kg BW) were fed for 70 d to a slaughter weight of 32 kg. Growth performance was measured as ADG and gain to feed (G:F). Blood samples were collected on d 1 and d 70 of the feeding trial. Goats were humanely slaughtered at the University of Missouri Abattoir. Carcass parameters of dressing percentage, chilled carcass weight (CW), pH 1hr, pH 24 hr (in the longissimus), and muscle conformation were recorded. At 24 hr postmortem, a 2.54 cm core was removed from the longissimus thoracis for fatty acid profile determination via gas chromatography. Mean ADG and G:F were 0.12 vs 0.11 ( $P = 0.37$ ) and 0.05 vs 0.04 ( $P = 0.06$ ) for CON and GLY, respectively. CON goats had heavier ( $P = 0.0001$ ) BW and heavier ( $P = 0.0001$ ) CW than GLY goats 35.4 vs 28.1 kg and 17.0 vs 12.7 kg, respectively. Carcass muscle conformation favored CON with 1.27 compared with 2.33 ( $P = 0.0001$ ). Fatty acid profile results showed minor differences for 16:1 (CON = 2.53%, GLY = 2.10%), 18:2 (CON = 0.19%, GLY = 0.12%), and 22:0 (CON = 0.29%, GLY = 0.48%). Calculated iodine value differed ( $P = 0.009$ ) with 50.6 and 49.2 for CON and GLY, respectively. The practical significance of this

difference is likely negligible. No significant changes were observed for SFA, MUFA, or PUFA in fatty acid profile data. These data indicate a tendency for decreased efficiency for meat goats fed 10% crude glycerol, resulting in lower BW at time of slaughter.

**Key Words:** goat, meat, glycerol

**326 Comparison of leadership traits among animal science majors.** C. M. Stephenson\*, K. D. Rubenthaler, S. A. Mark, A. K. Leimer, V. A. Koperski, D. R. Brink, and L. D. Moody, University of Nebraska-Lincoln, Lincoln.

Strength of leadership can vary based on organizational, influential, motivational, and leadership tools or instructions. This research project completed by the Animal Science Leadership Academy (ALA) at the University of Nebraska-Lincoln was created to discover differences in leadership among Animal Science students. It was also created to determine if leadership prior to college shows substantial separation within the Animal Science student population. The ALA prepared a survey consisting of 25 multiple choice questions pertaining to student demographics, leadership, influence, motivation, and organization. The survey was administered online via Blackboard Academic Site and was available to students within all of the Animal Science options.

The survey was completed by 83 students in Animal Science. A majority of the Animal Science students that participated in the survey were between the ages of 19 to 21 and have taken between 53 and 88 credits. The percentage that was female was 63.4%, and when observing the Animal Science option results, 43.9% of the students were in the Pre-Veterinary Science option with the remaining students representing the other options. Fifty-two percent of all Animal Science students surveyed had taken a leadership class in high school. The results indicated that the options (Pre-Veterinary vs. other options) were more comparable than we previously thought.

Although the number of Animal Science Pre-Veterinary students concluded to be leaders was significant, the type of leadership, influence, organization, and motivation still remain to be fairly close between both Animal Science option categories. This shows that some students think that they are leaders, but don't know how to exercise the type leadership to its fullest potential. The information collected by the survey could be used to implement leadership programs or tools within the Animal Science Department to acknowledge the strength and types of leadership that students possess.

**Key Words:** leadership, undergraduate, influence